

HP 9000 midrange servers from HP— The HP 9000 rp7440 and rp8440 Servers



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Executive summary

The HP 9000 rp7440 and rp8440 Servers and the PA-8900 processor bring you all the computing power you need to operate in the most demanding IT environments. Leading performance and compute density, coupled with the flexibility and scalability of the HP 9000 rp7440 and rp8440 Servers, allow you the agility and investment protection you need to meet today's commercial and technical computing demands while improving your return on IT. HP 9000 servers easily outpace the competition by providing a broader range of solutions with more applications at a higher performance. In addition, with flexible configurations, competitive pricing, and financial incentives, the HP 9000 rp7440 and rp8440 Servers make high-availability computing an affordable reality for your enterprise.

Powered by PA-RISC and HP-UX, the HP 9000 rp7440 and rp8440 Servers give you the performance and financial flexibility to power every application from Web serving to mission-critical enterprise resource management. Additionally with in-box upgrades, HP offers a solid roadmap to protect your investment, to current and future Intel® Itanium® processors, offering you tremendous capacity and scalability over time.

Adaptive, flexible, and scalable: The HP 9000 rp7440 and rp8440 Servers

Introduction

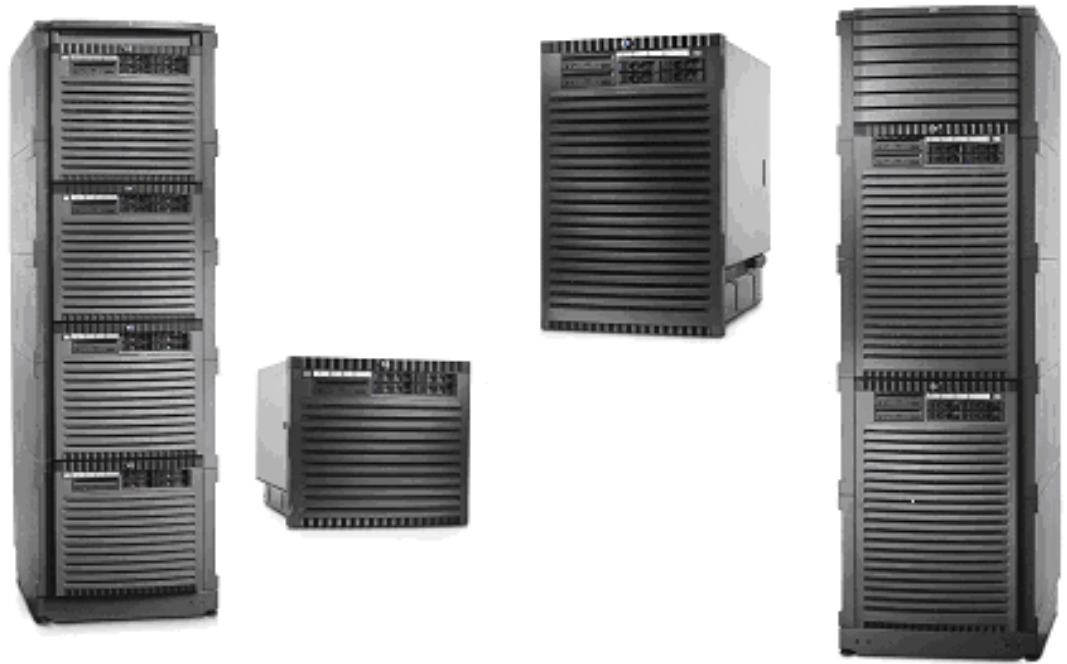
Today's HP 9000 servers outpace competitive servers by providing a broader range of solutions with more applications at a higher performance, across both commercial and technical computing. The HP 9000 server family offers hardware and software solutions for every tier of the enterprise, from entry-level to high-end enterprise computing, featuring the HP 9000 rp3410, rp3440, rp4410, rp4440, rp7440, and rp8440 Servers and the HP 9000 Superdome. This paper covers the midrange HP 9000 rp7440 and rp8440 Servers—two highly flexible and scalable members of the HP 9000 server family, powered by PA-8800 and PA-8900 processors.

New, innovative HP chipset delivers more power, availability, and manageability

The new HP enterprise systems chipset, the HP Super-Scalable Processor Chipset sx2000, is designed to provide the scalability, reliability, manageability, and performance to meet your most demanding server needs. The chipset, used in the latest HP 9000 high-end and midrange servers, supports the PA-RISC PA-8900 processor along with Intel Itanium 2 processors and creates a foundation for future upgrades to Itanium 2 processors. This capability offers the flexibility and longevity to maximize your return on IT investment.

This white paper introduces you to the technical details of the HP 9000 rp7440 and rp8440 Servers beginning by describing their modular designs, system architectures (including the HP Super-Scalable Processor Chipset sx2000), cell board design and configurations, and I/O subsystems. Every aspect of the operation and design of the HP 9000 rp7440 and rp8440 Servers is covered, including performance and scalability, unit racking, partitioning, manageability, serviceability, and high availability features.

Figure 1. HP 9000 rp7440 and rp8440 Servers



HP 9000 rp7440 and rp8440 Server specifications

	HP 9000 rp7440 Server with 8 PA-8900 processors	HP 9000 rp8440 Server with 16 PA-8900 processors	HP 9000 rp8440 Server Expansion Unit (SEU-2)
Cell boards	1–2	1–4	—
Dual-Core PA-8900 processors	1–8 processors (2–16 cores)	1–16 processors (2–32 cores)	—
1.068 GHz processors (533 MHz FSB)	2–8 processors	2–16 processors	—
Memory (1-GB, 2-GB, or 4-GB DIMMs)	2–128 GB	2–256 GB	—
Hot-plug PCI-X I/O slots	15 slots	16 slots	16 slots
Cell controller to I/O controller bandwidth	11.5 GB/s	11.5 GB/s	11.5 GB/s
PCI-X slot single bus bandwidth (qty.)	533 MB/s (2)	533 MB/s (2)	533 MB/s (2)
PCI-X slot Fat Link bandwidth (qty.)	1,066 MB/s (6)	1,066 MB/s (6)	1,066 MB/s (6)
PCI-X slot dual Fat Link Bandwidth (qty)	2,128 MB/s (8)	2,128 MB/s (8)	2,128 MB/s (8)
Internal disk storage slots/ max. capacity	4/1,200 GB	4/1,200 GB	4/1,200 GB
Internal removable media slots (DVD, DAT)	2 (with slim-line DVD+RW) 1 (with half-height devices)	2	2
Hard partitions	2	2 (4 with SEU-2)	—
Hot-swap redundant power supplies (N+1 included)	2	6	2
Hot-swap redundant fans (N+1 included)	Yes	Yes	Yes
High availability features	Hot-swap redundant fans and bulk power supplies Redundant power line inputs for dual grid protection Error checking and correcting (ECC) on all processor and memory paths Double Chip Spare Cell Link level retry and redundant links Parity-protected I/O data paths		
Operating systems	HP-UX 11i v1, v2, v3 (v2 support is planned in mid 2007; v3 support in planned in 2H 2007)		
Dimensions:			
Height—Rack	445 mm (17.5 in.)	755 mm (29.7 in.)	400 mm (15.75 in.)
—Pedestal	527 mm (20.75 in.)	833 mm (32.8 in.)	—
Width	482 mm (19.0 in.)	482 mm (19.0 in.)	482 mm (19.0 in.)

	HP 9000 rp7440 Server with 8 PA-8900 processors	HP 9000 rp8440 Server with 16 PA-8900 processors	HP 9000 rp8440 Server Expansion Unit (SEU-2)
Depth	762 mm (30.0 in.)	762 mm (30.0 in.)	762 mm (30.0 in.)
Typical maximum power consumption (for maximum configuration)	2120VA (2078 W)	3866VA (3789 W)	613VA (601 W)
Weight (max.)	101.6 kg (224 lb)	171.4 kg (378 lb)	81.6 kg (180 lb)

Figure 2. HP 9000 rp7440 Server

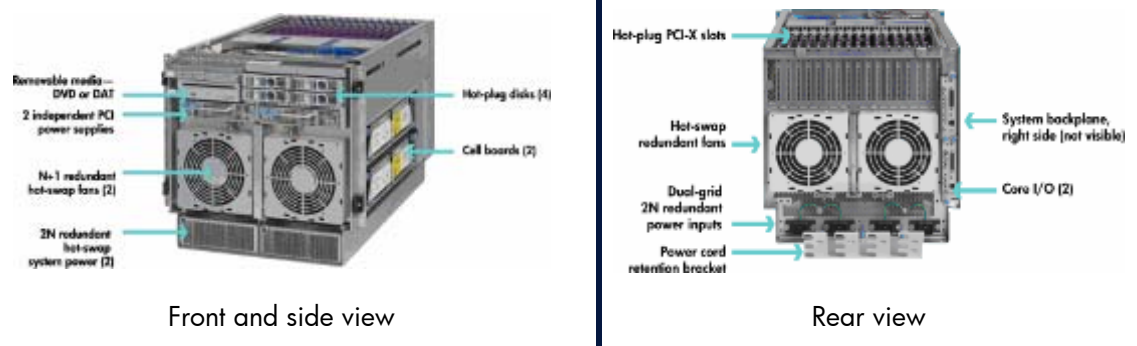


Figure 2 shows major components of the HP 9000 rp7440 Server, as well as the system's mechanical and architectural features. The HP 9000 rp7440 Server is shown with its front plastic bezel and top and left side panels removed.

A peripheral bay located at the top front of the HP 9000 rp7440 Server provides space for four hot-plug disk drives and one removable-media device (DVD or DAT) (two slimline DVDs +RWs are available for the HP 9000 rp7440 Server). Directly below the peripheral bay are two redundant PCI-X power bricks, which supply DC power for the PCI-X backplane. Below the power supplies are two redundant hot-swappable cooling fans. These fans pull cool air in from the front and force air to the rear, cooling the system's internal components. At the bottom is the bulk power supply (BPS) bay, which houses two redundant (2N) hot-swap power supplies with dual grid support.

Figure 2 also shows the right side of the HP 9000 rp7440 Server, with a view of the cell board bay, which supports up to two cell boards. The cell boards contain processors, memory, and cell controller chips.

The rear view of the HP 9000 rp7440 Server shows the location of the two hot-swappable 150-mm exhaust fans and the I/O bay bulkhead directly above them. The core I/O cards are located at the right edge of the unit.

The system backplane board houses the linkages used for communications between cell boards, I/O, and internal peripherals. The HP 9000 rp7440 Server I/O card bay is located at the top rear of the system. It contains 15 PCI-X card slots, all supporting hot-plug functionality.

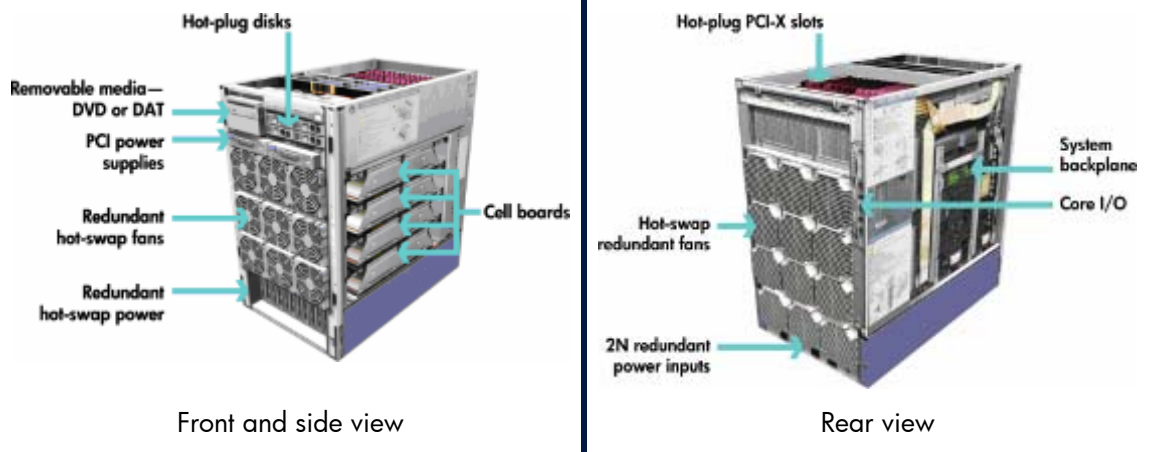
The bottom rear of the HP 9000 rp7440 Server has inputs for the 2+2 redundant line cords. Because of the high degree of connectivity offered in the HP 9000 rp7440 Server, a cable management arm (not shown) is provided for dressing cables and simplifying cable routing.

The HP 9000 rp7440 and rp8440 Servers share many system components and design features as seen below. Figure 3 shows a front/side and rear view of the HP 9000 rp8440 Server with its front plastic bezel and top and left side panels removed.

A peripheral bay located at the top front of the HP 9000 rp8440 Server provides space for four hot-plug disk drives and two removable media devices (DVD or DAT). Directly below the peripheral bay are two redundant PCI-X power bricks, which supply DC power for the PCI-X backplane. Below the power supplies are nine redundant hot-swappable cooling fans. These fans pull cool air in from the front and force air to the rear, cooling the system's internal components. At the bottom is the bulk power supply bay, which houses up to six redundant (2N+1) hot-swap power supplies.

Figure 3 also shows the side of the HP 9000 rp8440 Server, with a view of the cell card cage. This cage supports up to four cell boards on which processors, memory, and cell controller chips reside.

Figure 3. HP 9000 rp8440 Server



The rear view of the HP 9000 rp8440 Server shows the location of the 12 hot-swappable 120-mm exhaust fans and the I/O bay bulkhead directly above them. The core I/O cards are located at the right edge of the unit.

This view shows the system backplane board, which houses the high-bandwidth crossbar used for communications between cell cards, I/O, and internal peripherals. The HP 9000 rp8440 Server I/O card bay is located at the top rear of the system. It contains 16 PCI-X card slots, all supporting hot-plug functionality.

The bottom rear of the HP 9000 rp8440 Server has inputs for the 2+2 redundant line cords. Because of the high degree of connectivity offered in the HP 9000 rp8440 Server, a cable management arm specific for the HP 9000 rp8440 Server (not shown) is provided for dressing cables and simplifying cable routing.

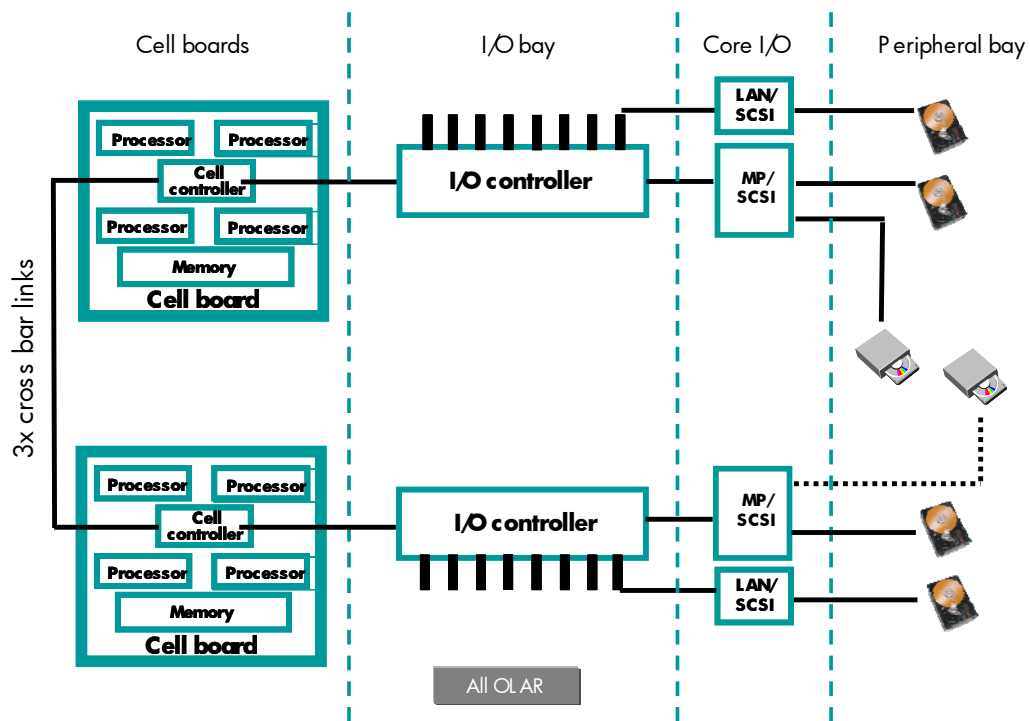
System architecture

HP 9000 midrange servers are built around HP sx2000 chipset which is based on a modular cell-based architecture. Cell-based architecture allows for components (cell boards, I/O and more) to be configured to effectively cover a wide range of computing needs. Both the HP 9000 rp7440 and rp8440 Servers support a variety of system configurations, ranging from one to sixteen PA-8900 processors. Both servers can be configured as large symmetric multiprocessing (SMP) systems or as multiple independent hard partitions called nPartitions (nPars). The basic components in the HP 9000 midrange servers are the cell board with processors and memory, the PCI-X based I/O subsystem, and, in the HP 9000 rp8440 Server, the crossbar backplane. These components fit together to provide a high-performance computing platform that is scalable, highly available, and flexible.

HP 9000 rp7440 Server architecture

The HP 9000 rp7440 Server architecture is designed around the ability to operate the system as a single one- to eight-processor SMP server or to divide it into two independent hard partitions (nPars). Figure 4 shows the primary components of the HP 9000 rp7440 Server architecture. When the system is configured as a non-partitioned server, all resources shown in Figure 4 are available to perform together as one logical server. When it is configured as two nPars, system resources are divided into two logical servers, or independent partitions, each containing a cell board with a dedicated set of I/O resources. For example, in Figure 4, imagine that the solid line connecting the upper and lower cell boards is no longer there. The drawing would then reflect a system divided into two independent partitions. The cell board, I/O bay, core I/O, and peripheral bay in the upper half of the drawing would be an independent hard partition, which is isolated from the second partition shown in the lower half of the drawing.

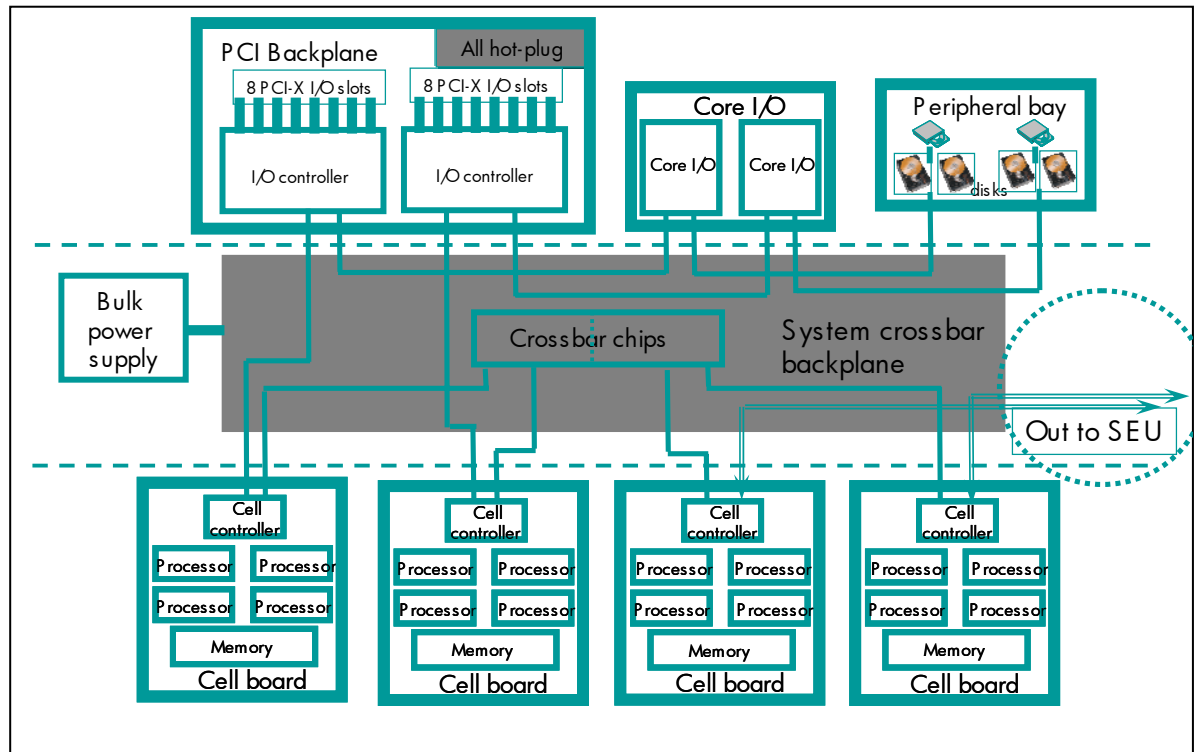
Figure 4. Architecture of the HP 9000 rp7440 Server, showing the basic modular building blocks of the system



HP 9000 rp8440 Server architecture

The HP 9000 rp8440 Server architecture builds on that of the HP 9000 rp7440 Server with the addition of a crossbar backplane and two more cell boards. The crossbar backplane provides a non-blocking connection between up to four cells, plus a connection to the external I/O resources in the HP SEU-2. Similarly to the HP 9000 rp7440 Server, the HP 9000 rp8440 Server can be configured as one 1- to 16-processors system, or it can be divided into smaller independent nPars. The HP 9000 rp8440 Server can be divided into four hardware-isolated partitions when connected to the SEU-2.

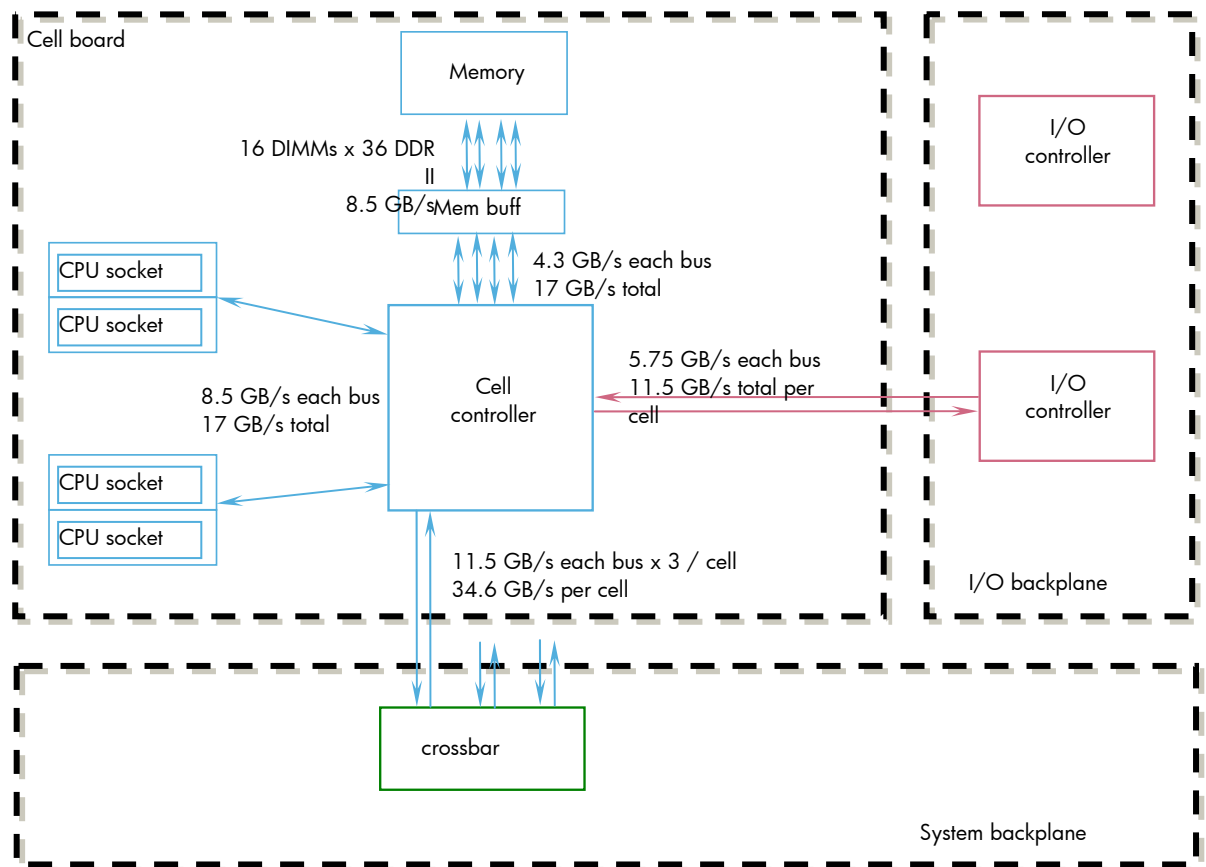
Figure 5. Architecture block diagram of the HP 9000 rp8440 Server, showing the modularity of the system



HP Super-Scalable Processor Chipset sx2000

The HP sx2000 is the HP enterprise class chipset that provides more than twice the memory bandwidth and over four times the I/O and fabric bandwidths of the sx1000 chipset, along with significant reductions in systems latencies. This increased capabilities of the HP sx2000 in combination with the Dual-Core PA-8900 processors delivers significantly greater performance for your applications. All sx2000 systems use error correcting and self-healing technologies throughout to reduce hardware outages. Unique technologies include Double Chip Spare (DCS), which immediately restores chip-spare protection after a DRAM has failed and protects against the majority of memory buffer and data bus failures, and link self-healing, which recovers from any connector, backplane, or cable failure without loss of performance.

Figure 6. Primary components of the HP sx2000 chipset



Cell boards

The cell, or cell board, is one of the basic building blocks of the HP 9000 midrange servers. A cell board is a module that primarily houses processors, memory, and the cell controller application-specific integrated circuits (ASICs).

Figure 7. Layout of the HP 9000 rp7440 and rp8440 Server cell board



Cell design details

Each cell board is a self-contained unit, with an SMP, main memory, and all necessary hardware.

- Processors—Up to four Dual-Core PA-8900 processors (or 8 processor cores/cell board)
- Cell Controller ASIC (CC)
- Memory Mux ASICs
- Main memory DDR-2 DIMMs (up to 16 DIMMs per cell board)
- Voltage regulator modules (VRMs)
- Cell management and processor-dependent hardware (PDH) circuitry

The CC is at the heart of each cell board. It provides the communications link between processors, memory, I/O, PDH, and adjacent cells. The CC contains interface logic and maintains cache coherency throughout the system. Adjacent to the cell controller ASIC are up to four PA-8900 processors and up to 256 GB of main memory (currently supports up to 64 GB of main memory using 4-GB DIMMs). Each cell interfaces with adjacent cells and I/O resources directly or, in the case of the HP 9000 rp8440 Server, to other cells through the crossbar backplane.

The primary function of the Memory Mux ASIC is to multiplex and de-multiplex data between the CC and the DIMMs in the memory subsystem. When the CC issues a read transaction to the memory interface command bus, the Memory Mux ASIC buffers the memory read data and returns it as soon as possible. When the CC issues a write transaction, the memory controller ASIC receives the write data from the CC and forwards it to the memory.

The sx2000 chipset has twice the memory bandwidth of the sx1000 and over 25% lower memory access latency when compared to the sx1000.

The CC also supports DCS, an increased level of memory availability. The memory error correcting logic reestablishes chip-spare correction after another DRAM in the same error checking and correcting (ECC) codeword has failed. This strategy is more cost-effective than memory mirroring methods for protecting memory. See the HP sx2000 chipset technical white paper for more information on this feature.

Cell configurations

The HP 9000 rp7440 Server supports up to two cells. The HP 9000 rp8440 Server supports up to four cells. With Dual-Core PA-8900 processors, each cell can be configured with up to four active processors. When configured with PA-8900 processors, each cell can be purchased with one to four active PA-8900 processors. A fully loaded HP 9000 rp7440 Server therefore contains eight PA-8900 processors. A fully loaded HP 9000 rp8440 Server therefore contains sixteen PA-8900 processors. They can also be purchased in combination with inactive HP Instant Capacity (iCAP) processors.

Within the cell, CPU-to-CC peak bandwidth has been increased to 17 GB/s (13.6 GB/s sustained).

The minimum supported cell configuration is one active Dual-Core processor and 2 GB of memory per cell board. The maximum configuration includes four active Dual-Core processors and 64 GB of memory per cell board in the HP 9000 rp7440 Server. The HP 9000 rp8440 Server supports a maximum of four active Dual-Core processors and 64 GB of memory per cell board. DIMM modules are sold in sets of two, with available DIMM sizes of 1 GB, 2 GB, and 4 GB. Memory pairs of different sizes can be mixed within a chassis and within a cell. However, for optimum memory interleaving and performance, HP recommends that one memory size be selected, distributed evenly across available cells, and loaded in increments of eight DIMMs.

Within a cell, the CC-to-memory peak bandwidth is 17.2 GB/s, a 2.1X improvement compared to sx1000. Memory is accessed directly through the CC, so all memory slots are accessed, regardless of the number of processors loaded on the cell.

Memory latency

There are two types of memory latency within the HP 9000 rp7440 Server:

- **Memory latency within the cell** refers to the case in which an application runs on a partition that consists of a single cell or uses cell local memory.
- **Memory latency between cells** refers to the case in which the partition consists of two cells and cell interleaved memory is used. In this case, 50% of the addresses are to memory on the same cell as the requesting processor, and the other 50% of the addresses are to memory on the other cell.

The HP 9000 rp7440 Server average memory latency depends on the number of processors in the partition. Assuming that memory accesses are equally distributed across all cell boards and memory controllers within the partition, the average idle memory latency (load-to-use) is shown in the following table.

Number of processors per partition	Average memory latency
4 processors (one cell)	~185 ns
8 processors (two cells)	~249 ns

There are two types of memory latency within the HP 9000 rp8440 Server:

- **Memory latency within the cell** refers to the case in which an application runs on a partition that consists of a single cell or uses cell local memory.
- **Memory latency between cells** refers to the case in which the partition consists of two or more cells and cell interleaved memory is used. For example, for an HP 9000 rp8440 Server with four cells in the partition, 25% of the addresses are to memory on the same cell as the requesting processor, and the other 75% of the addresses are to memory on the other three cells.

The HP 9000 rp8440 Server average memory latency depends on the number of processors in the partition. Assuming that memory accesses are equally distributed across all cell boards and memory controllers within the partition, the average idle memory latency (load-to-use) is shown in the following table.

Number of processors per partition	Average memory latency
4 processors (one cell)	~185 ns
8 processors (two cells)	~249 ns
16 processors (four cells)	~334 ns

Cell hot-plug

The HP 9000 rp7440 and rp8440 Servers support cell hot-plug. Coupled with the partitioning capability¹ of the servers and appropriate support from the operating system, cell hot-plug allows for the servicing of cell boards within a single partition while the other partition continues normal operation. Any number of configuration changes can be made to the partition being serviced, including replacing the complete cell board, adding or deleting processors and memory, or even increasing or decreasing the number of cells in that partition. (Cell hot-plug is supported only in systems with two or more partitions.)

Crossbar backplane

The next basic building block of the HP 9000 rp8440 Server is the crossbar backplane. The crossbar backplane contains two crossbar chips that provide non-blocking connections between four cells and their associated memory and I/O. Each cell has three connections to the crossbar fabric. The HP 9000 rp7440 Server does not have a crossbar backplane, so communication between its cells is over three direct-connect links.

Crossbar chips and links

The Crossbar ASIC is yet another part of the HP sx2000 chipset. The Crossbar ASIC and CC communicate over a high-speed SERDES-based link using 8 bit/10 bit encoding with clock/data recovery. As a result, there is no critical clock signal in any link that could be a single point of failure for that link.

The peak bandwidth for each port has been increased as well to 11.5 GB/s (9.2 GB/s typical), giving aggregate peak bandwidth of 34.5 GB/s (27.6 GB/s typical) per cell. In addition to

¹ The HP 9000 rp8440 Server can be configured as a single large SMP server or hardware-partitioned into up to four smaller logical servers. See "nPartitions" for more details about partitioning.

providing higher bandwidth, the crossbar fabric consisting of the Crossbar ASIC and high-speed links have been redesigned for the sx2000 to provide greater availability and reliability.

See the HP sx2000 chipset technical white paper for more information on the benefits provided by new Crossbar ASIC and links.

I/O subsystem

Each HP 9000 rp7440 and rp8440 Server contains an embedded high-performance I/O subsystem. In addition, the HP 9000 rp8440 Server can optionally connect to external I/O resources located in the HP SEU-2 through a high-performance I/O cable link. The components within the I/O subsystem are the I/O controllers, internal peripheral bay, and multifunction core I/O. Basic block diagrams for the HP 9000 rp7440 and rp8440 Server I/O subsystems are shown in Figures 8 and 9.

Figure 8. Basic block diagram of the HP 9000 rp7440 Server I/O subsystem

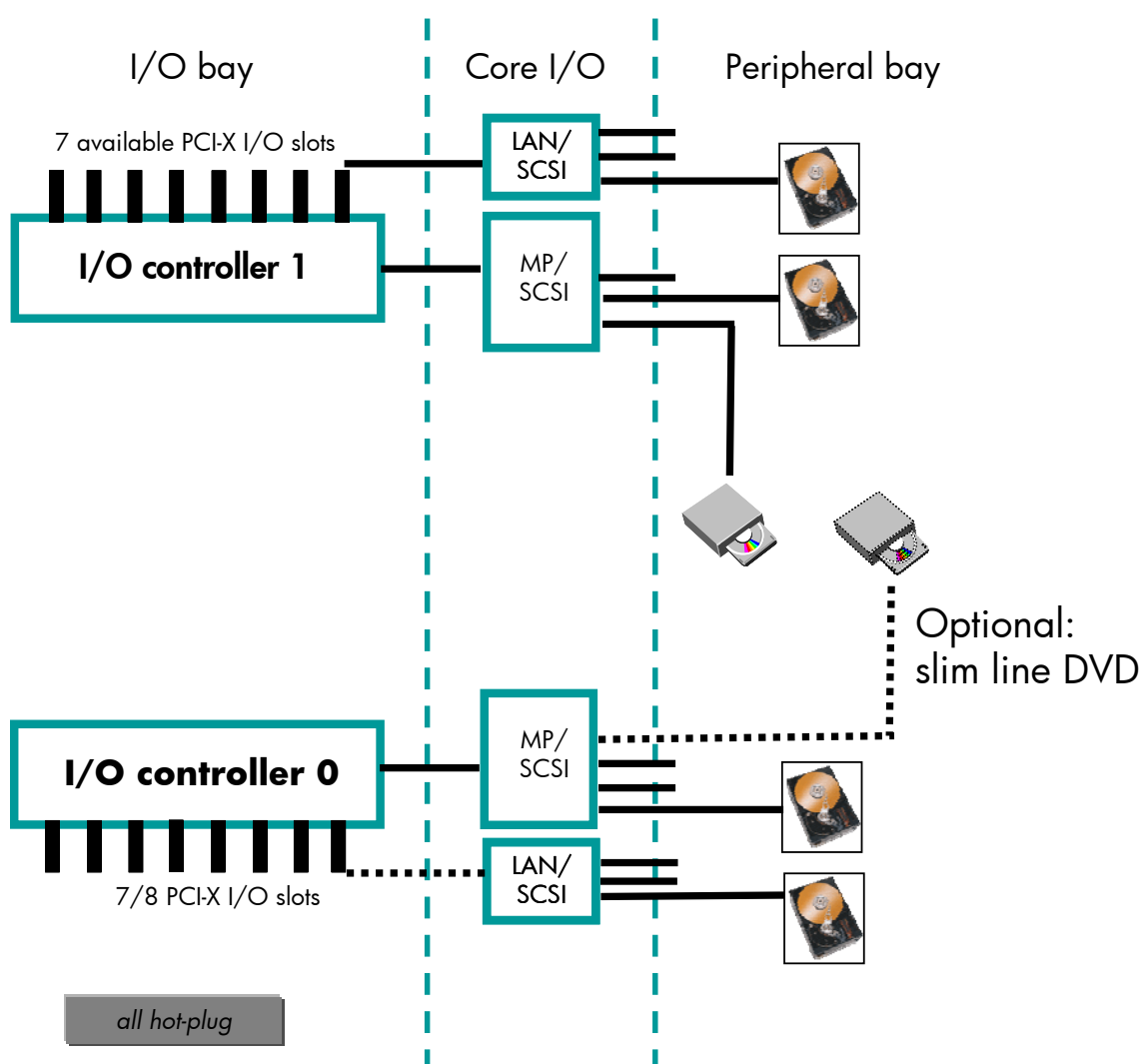
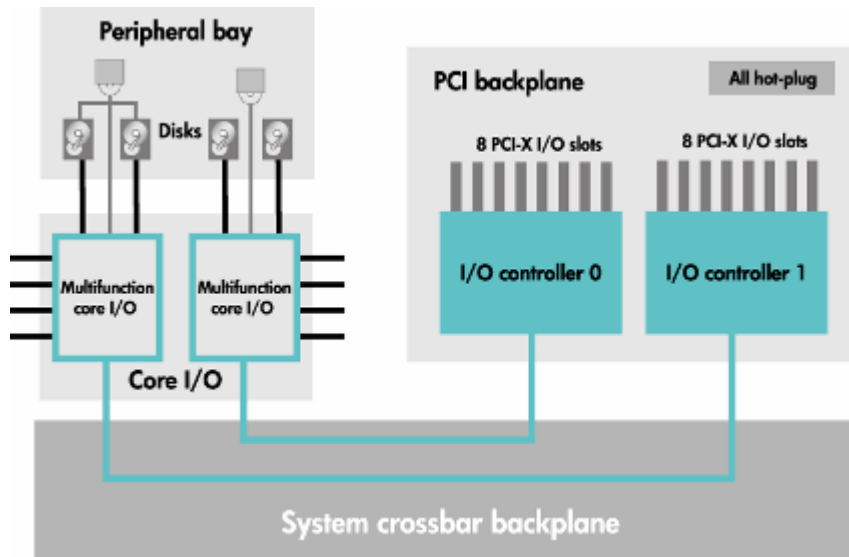


Figure 9. Basic block diagram of the HP 9000 rp8440 Server I/O subsystem



I/O controller chips

The HP 9000 rp7440 and rp8440 Servers contain two master I/O controller chips located on the PCI-X backplane. Each I/O controller contains 16 high-performance, 12-bit-wide links. These links connect to 16 I/O controller chips supporting the PCI-X card slots and core I/O.

In both systems, two links—one from each master controller—are routed through the system backplane and are dedicated to core I/O. The remaining 30 links are divided among the sixteen 64-bit PCI-X card slots, with each slot on a dedicated PCI-X bus. This one-card-per-bus architecture leads to greater I/O performance, better error containment, and higher availability.

Each controller chip is also directly linked to a host cell board, which means that two cell boards, located in cell slots 0 and 1, must be purchased to access all available I/O card slots. (With one cell board, access to half of the available slots is enabled.)

PCI-X backplane

Figures 10 and 11 show detailed views of the HP 9000 rp7440 and rp8440 Server PCI-X backplanes. The I/O slot implementations between the two servers are almost identical—the difference is the use of one or two slots by the HP 9000 rp7440 Server core I/O. In both figures, note that eight of the 16 I/O card slots are supported by dual high-performance fat links. These dual-link I/O slots provide a maximum of 2.1 GB/s of peak bandwidth for the slot. Six of the 16 I/O card links are supported by high-performance fat links. These fat link slots provide a maximum of 1.06 GB/s of peak bandwidth for the slot. The remaining two I/O slots are single links and provide a maximum of 530 MB/s of peak bandwidth. Aggregate I/O slot bandwidth is approximately 25 GB/s or a 4.4x increase in bandwidth compared to the sx1000 platforms.

These platform supports eight 266-MHz slots, which means that these I/O slots allows the industry's highest-performing PCI-X cards to run at their maximum design speed.

Figure 10. The PCI-X backplane of the HP 9000 rp7440 Server has fat link high-performance links for 14 of the 16 I/O card slots.

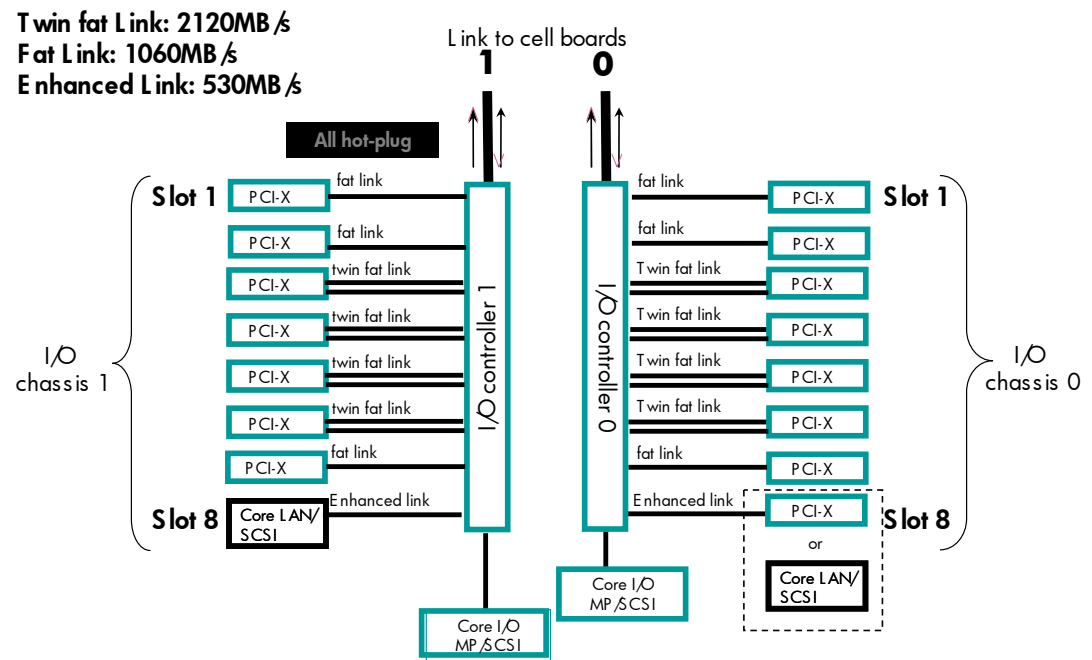
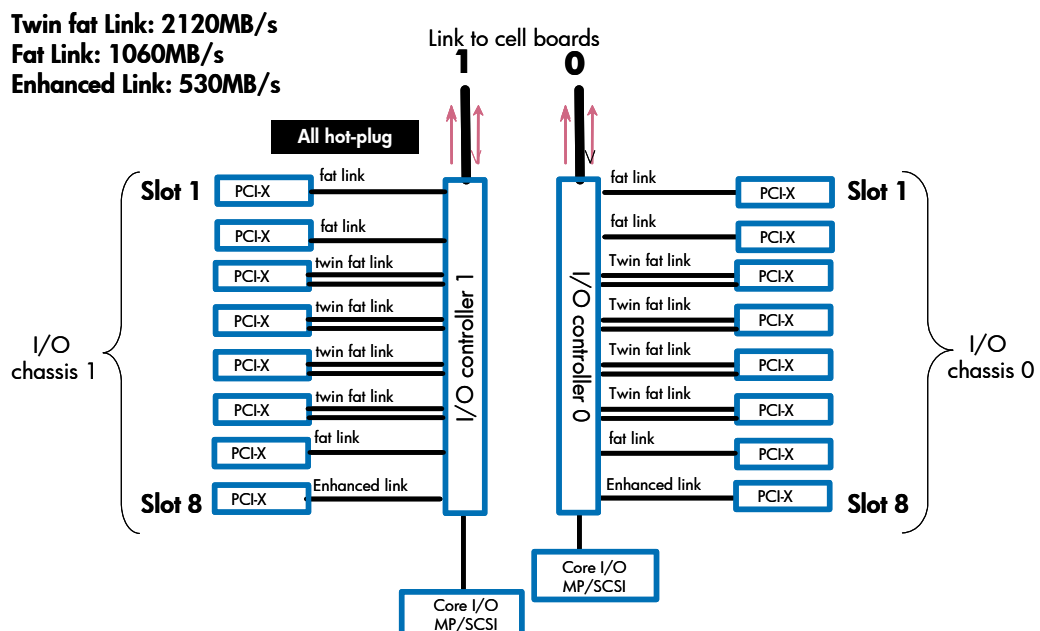


Figure 11. The PCI-X backplane of the HP 9000 rp8440 Server has fat link high-performance links for 14 of the 16 I/O card slots.



In practice, PCI-X I/O cards requiring the largest amount of bandwidth should be configured into the dual-link slots. Because each I/O slot has a dedicated bus, any slot can be hot-plugged or serviced without affecting other slots.

Core I/O

The HP 9000 rp7440 and rp8440 Servers are purchased with one or two core I/O card products. In both systems, core I/O provides console, Ultra320 SCSI, Gigabit LAN, and Management Processor (MP) functionality, along with SCSI controllers for the peripheral bay. The second core I/O product can be used to enable dual partitioning, provide access to a second set of disk drives, and provide redundant MP functionality. In the HP 9000 rp8440 Server, the second core I/O product also enables the use of an additional removable media device. Although core I/O provides the same functionality in both the HP 9000 rp7440 and rp8440 Servers, the physical implementation is different. To accommodate size limitations, the core I/O in the HP 9000 rp7440 Server is divided across two separate boards, while the core I/O in the HP 9000 rp8440 Server is implemented on one physical board. The following sections detail the core I/O implementation in each system.

HP 9000 rp7440 Server core I/O

The HP 9000 rp7440 Server chassis supports up to two core I/O card sets. Each set contains two cards (MP/SCSI and LAN/SCSI), which are installed in different locations: MP/SCSI cards are installed along the right rear vertical edge of the chassis; LAN/SCSI cards are installed in the PCI-X card bay. A minimum of one core I/O card set must be ordered with each system; the optional second core I/O card set can be used to enable hardware partitioning or to utilize the full capacity of the built-in mass storage bays.

Both core I/O card sets are identical. In the primary and secondary core I/O set, the LAN/SCSI board is supported by a single 530 MB/s link. In the primary and secondary core I/O set, the two SCSI controllers—one in the LAN/SCSI card and one in the MP/SCSI card—each support a single internal disk drive.

Figure 12. Block diagram showing basic core I/O card set (primary) in the HP 9000 rp7440 Server

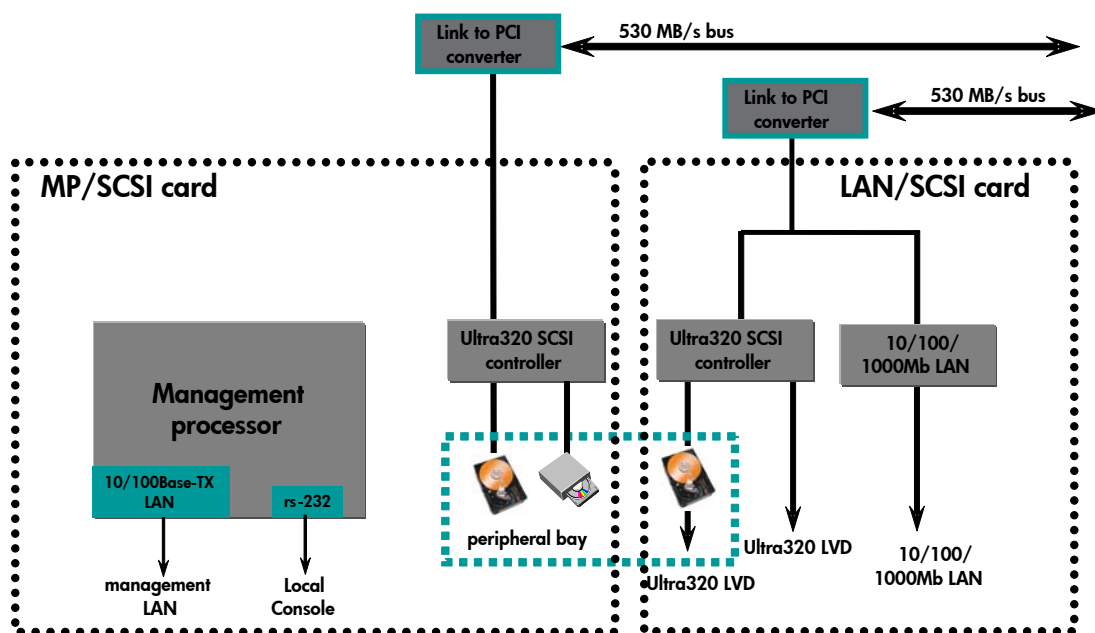
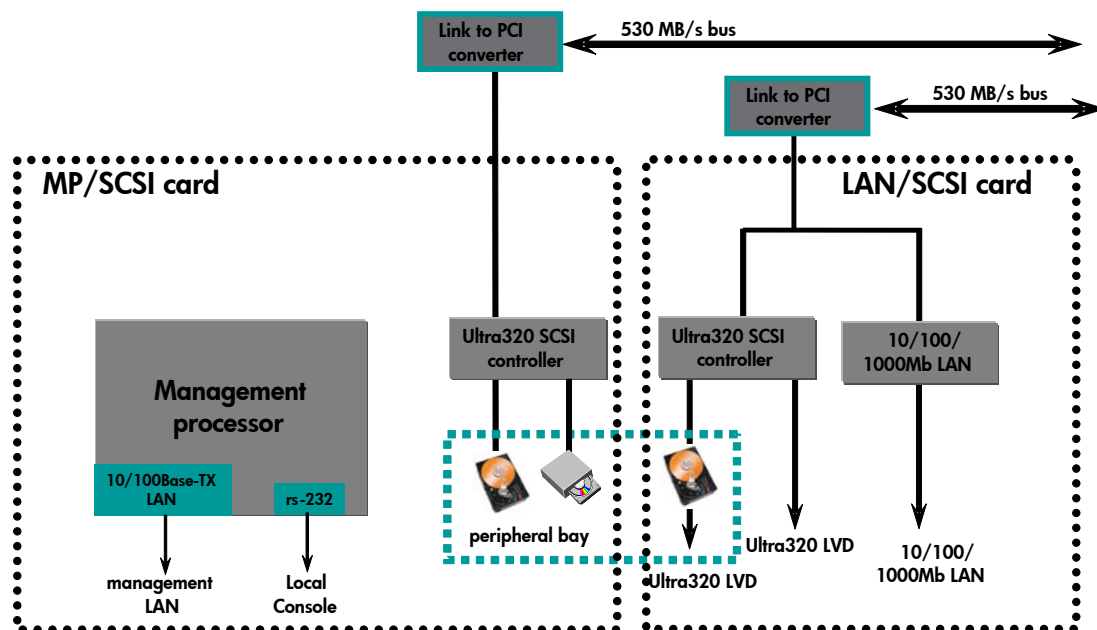


Figure 13. Basic core I/O card set (secondary)



Management Processor—The MP is a dedicated processor located on each MP/SCSI card that simplifies and extends system management and enhances serviceability. The MP reduces the need for the system administrator to be physically at the system to perform tasks such as diagnostics, system management, or even hard resets. The HP 9000 rp7440 and rp8440 Server MP offers the following features, among others:

- System management over the Internet or intranet
- System console redirection
- Console mirroring
- System configuration for automatic restart
- Viewing history log of system events and console activity
- Setting MP inactivity timeout thresholds
- Remote system control
- Remote power cycle (except for MP housekeeping power)
- Viewing system status
- Event notification to system console, e-mail, pager, or HP Response Centers (e-mail and pager notification work in conjunction with HP Event Monitoring Service [EMS])
- Automatic hardware protection of critical environmental problems
- Automatic system restart
- Remote resetting of hardware partitions
- Forward progress indicator (through a virtual front panel)
- Out-of-band manageability and processor-dependent code (PDC) firmware update
- Configuration of manageability and console security
- MP failover (systems with both core I/O boards)
- Secure Sockets Layer (SSL)

External LAN—The external LAN port is a 10/100/1000BaseT external LAN port that uses an RJ-45 connector.

External SCSI—The external SCSI port is an Ultra320 LVD external SCSI port for connections to mass storage or media.

HP 9000 rp7440 Server internal peripheral bay

The HP 9000 rp7440 Server internal peripheral bay is located at the top front of the system chassis. The peripheral bay holds up to four low-profile hot-plug disks and one removable media device (either half-height DVD or DAT) or supports up to two low-profile (slim-line) DVDs.

Each HP 9000 rp7440 Server core I/O card set contains dual-channel Ultra320 SCSI controller chips that support the SCSI devices in the internal peripheral bay. Each core I/O card set supports two internal disks. Separate controllers and SCSI buses manage the two disks supported by the primary core I/O card set.

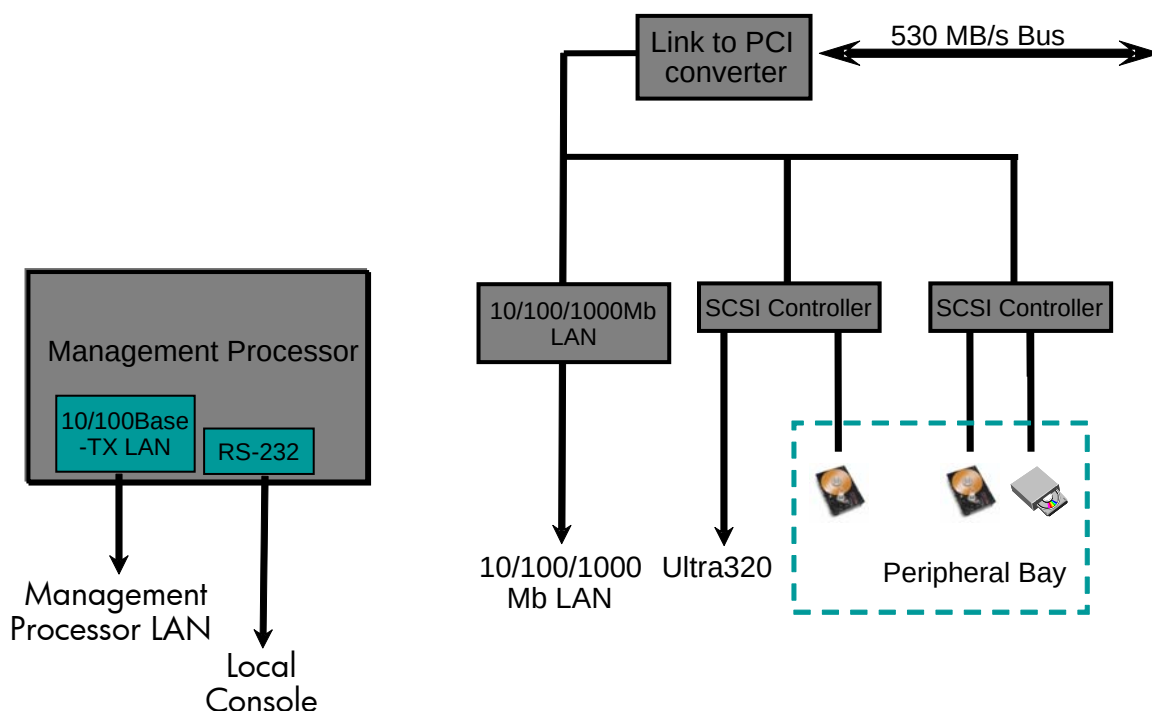
Internal disks—The HP 9000 rp7440 Server holds up to four SCSI disks, which are accessible from the front of the server. These hot-plug disks can be removed and inserted while the HP 9000 rp7440 Server continues to operate. The system supports the following disks: 36 GB, 15,000 rpm; 73 GB, 15,000 rpm; 146 GB, 10,000 rpm; and 300 GB, 10,000 rpm.

Removable media—The HP 9000 rp7440 Server contains one removable-media bay, which supports a half-height DVD drive, a half-height DAT drive, or two low-profile (slim-line) DVDs. Access to these devices is also from the front. The DVD drives provides enhanced features while preserving backward read compatibility with CD-ROM drives. Data transfer rates of up to 6.75 MB/s are achieved with the DVD format; 4.8 MB/s can be achieved using the CD-R format. The DAT drive has a maximum storage capacity of 72 GB, with a peak transfer rate of 21.6 GB/hour (compressed).

HP 9000 rp8440 Server core I/O

The HP 9000 rp8440 Server chassis supports up to two core I/O cards, installed in core I/O slots located along the right-rear vertical edge of the chassis. A minimum of one core I/O card must be ordered with each system; the optional second core I/O card can be used to enable hardware partitioning or to utilize the full capacity of the built-in mass storage bays.

Figure 14. Diagram showing the basic core I/O in the HP 9000 rp8440 Server



The core I/O management processor, external LAN port, and external SCSI port functionality in the HP 9000 rp8440 Server is the same as described in the HP 9000 rp7440 Server core I/O section. However, there are slot count and bus routing differences in the peripheral bay implementation. The following section pertains specifically to the HP 9000 rp8440 Server peripheral bay.

Access to internal peripheral bay—The first core I/O card enables half of the HP rp8440 Server peripheral bay, which includes one removable-media device and two low-profile disks. The second core I/O card enables the remaining internal peripherals, two disks, and one removable media bay. If you require access to more than two internal disks or more than one removable media slot, you need the second core I/O card and a minimum of two cell boards.

HP 9000 rp8440 Server internal peripheral bay

The HP 9000 rp8440 Server internal peripheral bay is located at the top front of the system chassis. The peripheral bay holds up to four low-profile hot-plug disks and two removable media devices.

Each HP 9000 rp8440 Server core I/O card contains two dual-channel SCSI controller chips that support the SCSI devices in the internal peripheral bay. Each core I/O card supports two internal disks and one removable media device, each on a dedicated 40 MB/s SCSI channel. If use of more than two internal disks or one removable-media device is needed, the HP 9000 rp8440 Server requires both core I/O cards. This architecture also provides an added degree of availability by supporting full disk mirroring across independent buses, controllers, core I/O cards, and master I/O controller chips.

Hot-plug disk drives—The HP 9000 rp8440 Server holds up to four SCSI disks, which are accessible from the front of the server. These hot-plug disks can be removed and inserted while the HP 9000 rp8440 Server continues to operate. Three disk sizes are currently supported: 36 GB, 15,000 rpm; 73 GB, 15,000 rpm; 146 GB, 10,000 rpm; and 300 GB, 10,000 rpm.

Removable-media bays—The HP 9000 rp8440 Server contains two removable-media bays, which support a half height DVD drive or a half-height DAT drive. Access to these devices is also from the front of the server. The DVD drive provides enhanced features while preserving backward read compatibility with CD-ROM drives. Data transfer rates of up to 6.75 MB/s are achieved with the DVD format; 4.8 MB/s can be achieved using the CD-R format. The DAT drive has a maximum storage capacity of 72 GB, with a peak transfer rate of 21.6 GB/hour (compressed).

HP Server Expansion Unit 2

The HP Server Expansion Unit 2 (SEU-2) is an add-on chassis containing I/O resources that complement the I/O and partitioning capabilities within the HP 9000 rp8440 Server. The HP 9000 rp8440 Server contains built-in ability to connect to the HP SEU-2. Connection to the SEU-2 doubles the amount of the HP 9000 rp8440 Server I/O resources, and the SEU-2 enables the creation of two additional nPars within the chassis. The following features are provided by the SEU-2:

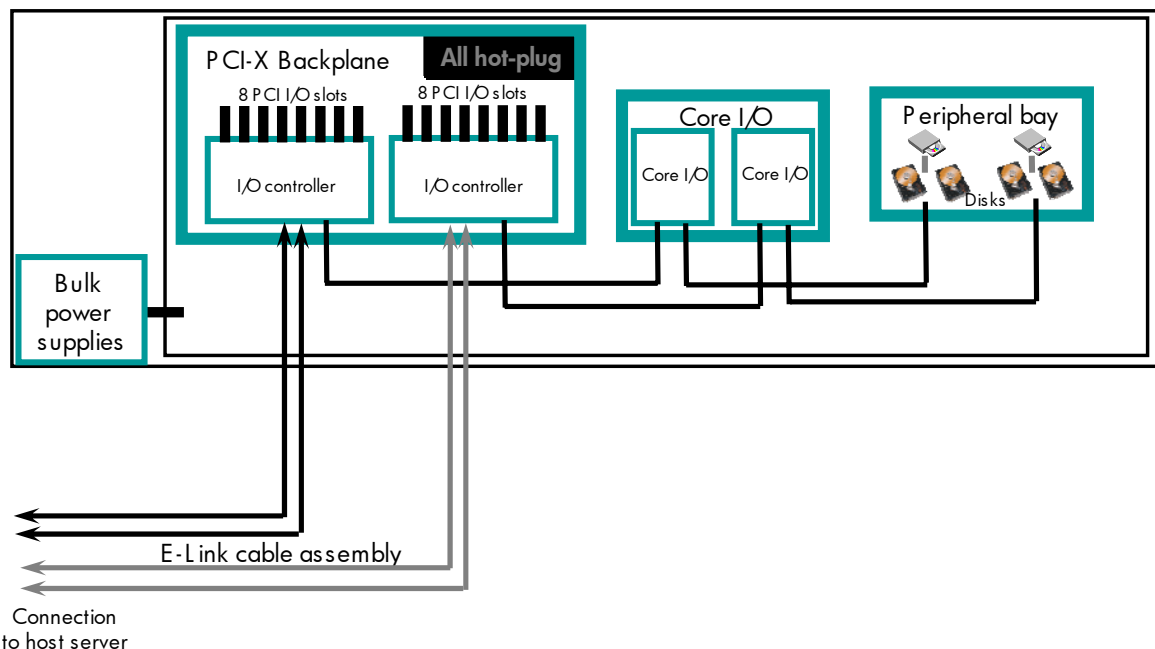
- Sixteen high-performance PCI-X I/O slots
- Eight slots that are 266-MHz x 64-bit capable
- Six slots that are 133-MHz x 64-bit capable
- All slots support hot-plug
- All slots supported by independent dual or single links
- Four disk drive bays
- Two removable half-height media slots (either DVD or DAT)
- Two additional nPars in the HP 9000 rp8440 Server host are enabled
- Two core I/O slots
- Redundant and hot-swap fans and bulk power supplies
- Redundant line cords for dual grid support
- 9U rack-mount chassis
- Certified under Uptime Institute's Fault Tolerant Power Compliance Specification

Figure 15. The HP SEU-2 (left) and the SEU-2 + HP 9000 rp8440 Server mounted in an HP 2-m cabinet (right)



The HP SEU-2 mirrors the I/O resources embedded within the HP 9000 rp8440 Server chassis, both physically and electrically. The high-speed connection between the HP 9000 rp8440 Server and the SEU-2 is provided through a remote I/O (E-Link) cable. The E-Link cable mounts directly to the system backplane board in the HP 9000 rp8440 Server and to the I/O backplane board in the SEU-2.

Figure 16. The HP SEU-2 block diagram



AC power subsystem

The HP 9000 rp7440 and rp8440 Servers were designed to take full advantage of the multi-grid power inputs found in today's high-end data centers, which means that both servers can connect to two independent power grids at the same time and tolerate a grid failure without causing computing interruptions. The power subsystems are so robust that they both are certified (without deviations) under the Uptime Institute's Fault Tolerant Power Compliance Specification. The specific AC power subsystem details are covered separately in the following sections.

Fault-tolerant power compliance in the HP 9000 rp7440 Server

The AC input to the HP 9000 rp7440 Server is divided into four separate circuits. Each circuit is fed by any 50- to 60-Hz high line source through four line cords ("high line" refers to 200 to 240 V operation). A minimum of two power cords is used to maintain normal operation of the HP 9000 rp7440 Server. A second set of two cords is added to improve system availability by protecting, for example, against power grid failures, failed power supplies, or accidentally tripped circuit breakers. Four power cords are used to enable redundancy and hot-swap functionality of the bulk power supplies. This power is routed from four individual 20-A circuit breakers through input line filters to two internal bulk power supplies (BPSs). These four lines are labeled A0, B0, A1, and B1 at the line filter inputs on the back panel of the HP 9000 rp7440 Server.

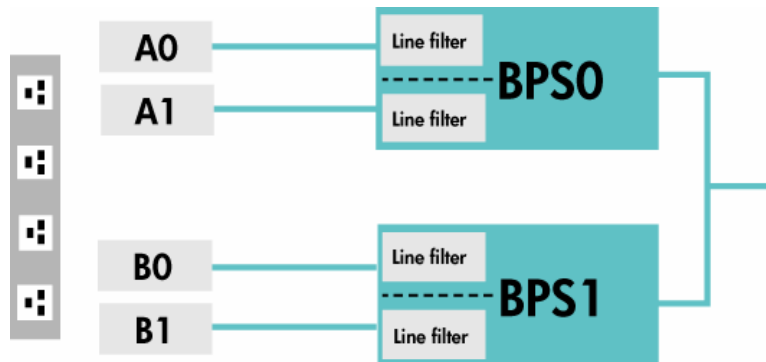
Figure 17 shows the HP 9000 rp7440 Server power configuration. Each AC inlet feeds one HP 9000 rp7440 Server BPS, and those two separate AC inlets feed each bulk supply. The design of the individual BPSs and the configuration of the interconnect meet all the conditions for fault-tolerant power compliance.

The benefit of this design is that when utilizing all four power cords, the HP 9000 rp7440 Server has 2N redundant power protection.

The dual AC modular bulk power supplies provide:

- Redundancy for both hardware failures and power input failures
- Hot-plug capability for any BPS in a redundant configuration
- Better data security, maintenance scheduling, and maintenance operations without system interruption

Figure 17. Power inputs and interconnects in the HP 9000 rp7440 Server are designed for fault-tolerant power compliance.



Fault-tolerant power compliance in the HP 9000 rp8440 Server

The AC input to the HP 9000 rp8440 Server is divided into four separate circuits. Each circuit is fed by any 50- to 60-Hz high line source through four line cords ("high line" refers to 200 to 240 V operation). A minimum of two power cords is used to maintain normal operation of the HP 9000 rp8440 Server. A second set of two cords is added to improve system availability by protecting, for example, against power grid failures or accidentally tripped circuit breakers. Four power cords are used to enable redundancy and hot-swap functionality of the bulk power supplies. This power is routed from four individual 20-A circuit breakers through input line filters to six internal bulk power supplies. These four lines are labeled A0, B0, A1, and B1 at the line filter inputs on the back panel of the HP 9000 rp8440 Server.

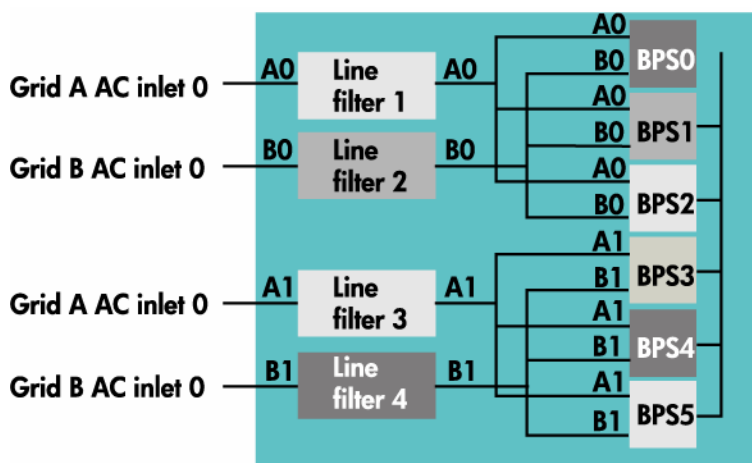
Figure 18 shows the HP 9000 rp8440 Server power configuration. Each AC inlet feeds three HP 9000 rp8440 Server BPSs, and two separate AC inlets feed each bulk supply. The design of the individual BPSs and the configuration of the interconnect meet all the conditions for fault-tolerant power compliance.

Each BPS shown in Figure 18 can be thought of as two sub-power supplies housed in a single BPS module. If only Grid A power cords are used, only one of the two sub-power supplies is in use. The other supply is off until the Grid B cords are used. The benefit of this design is that when utilizing all four power cords, the HP 9000 rp8440 Server has 2N+1 redundant power protection.

The dual AC modular power supplies provide:

- The ability to purchase only the amount of power conversion necessary for the intended HP 9000 rp8440 Server configuration
- Redundancy for both hardware failures and power input failures
- Hot-plug capability for any BPS in a redundant configuration
- Better data security, maintenance scheduling, and maintenance operations without system interruption

Figure 18. Power inputs and interconnects in the HP 9000 rp8440 Server are designed for fault-tolerant power compliance.



AC power consumption

The power consumption of the HP 9000 rp7440 and rp8440 Servers varies greatly, depending on the hardware configuration and the input line voltages supplied at your site. HP represents power consumption in terms of volt-amperes (VA) to take into account power factor correction.

- **Maximum Theoretical Power or Maximum Configuration**—The calculated sum of the maximum worst case power consumption for every subsystem in the server. This number is not exceeded by a functioning server for any combination of hardware and software under any conditions.
- **Marked Electrical Power**—The server Marked Electrical Power is the rating given on the chassis label and represents the input power required for facility AC power planning and wiring requirements. This number represents the expected maximum power consumption for the server based on the power rating of the bulk power supplies. Also, this number can safely be used to size AC circuits and breakers for the system under all conditions.
- **Typical Maximum Power, User Expected Maximum Power, or Typical Configuration**—The measured maximum worst case power consumption. This number represents the largest power consumption that HP engineers were able to produce for the server with any combination of hardware under laboratory conditions using aggressive software applications designed specifically to work the system at maximum load. This number can safely be used to compute thermal loads and power consumption for the system under all conditions.

Power numbers per configuration are shown below. For more detail information on power consumption details for these servers, please refer to the HP 9000 rp7440 or rp8440 Server Installation guide at <http://docs.hp.com>.

Typical value represents the expected power consumption of a given configuration. The typical value is the approximate power consumption that you most likely experience. It can be used for power budgeting purposes.

Following are the typical power consumption values for two different configurations of each server.

HP 9000 rp7440 Server fully loaded configuration with eight PA-8900 processors—Consists of eight 1.068-GHz PA-8900 processors, 64 GB of memory, 14 PCI-X cards, two cell boards, four internal hard drives, one DVD drive, two core I/O card sets, and two bulk power supplies.

- Typical maximum power: 2120 VA (2078 W) (10.6 A @ 200 VAC across two cords)
- Marked Electrical for the server: 2640 VA (12A @ 220 VAC across two cords)
- Marked Electrical per line cord: 1320VA (6A @ 220 VAC across each cord)
- Maximum Theoretical Power: 3130 VA (3092 W)

HP 9000 rp7440 Server average configuration with four PA-8900 processors—Consists of four 1.068 GHz PA-8900 processors, 10 GB of memory, five PCI-X cards, two cell boards, two internal hard drives, one DVD drive, one core I/O card set, and two bulk power supplies.

- Typical power consumption: 1080 VA (5.4 A at 200 VAC across 2 cords)

HP 9000 rp8440 Server fully loaded with 16 PA-8900 processors—Consists of 16 1.068 GHz PA-8900 processors, 128 GB of memory, 16 PCI-X cards, four cell boards, four internal hard drives, two DVD drives, two core I/O cards, and six bulk power supplies.

- Typical maximum power: 3,866 VA (3,789 W) (19.33 A @ 200 VAC across 2 cords)
- Marked Electrical for the server: 5400 VA (30A @ 180 VAC across 2 cords)
- Marked Electrical per line cord: 2700 VA (15A @ 180 VAC across each cord)
- Maximum theoretical power: 5,837 VA (5,720 W)

HP 9000 rp8440 Server average configuration with eight PA-8900 processors—Consists of eight 1.068 GHz PA-8900 processors, 16 GB of memory, eight PCI-X cards, two cell boards, two internal hard drives, one DVD drive, two core I/O cards, and four bulk power supplies.

- Typical power consumption: 1830VA (9.15 A at 200 VAC across 2 cords)

Performance and scalability

The HP 9000 rp7440 and rp8440 Servers continue to provide leading-edge performance and scalability to the midrange server market. After factoring in racking density, HP midrange servers maintain performance density at least double that of the competition.

The following section summarizes the main performance and scalability characteristics of the HP 9000 rp7440 and rp8440 Servers.

Important speeds and feeds

	HP 9000 rp7440 Server	HP 9000 rp8440 Server
Crossbar bandwidth per cell (peak)	NA	34.5 GB/s
Cell controller to I/O subsystem bandwidth (peak)	11.5 GB/s for each cell	11.5 GB/s for each cell
I/O slot bandwidth (peak)	23 GB/s	46 GB/s*
Memory bus bandwidth (peak)	34 GB/s	68 GB/s

Scalability

	HP 9000 rp7440 Server	HP 9000 rp8440 Server
Cell boards	1–2	1–4
PA-8900Processors	1–8	1–16
Memory	2–128 GB	2–256 GB
Hot-plug PCI-X I/O slots	15 slots	16 slots
Partitions	1–2	1–2 (4*)
Hot-plug internal disks	0–4	0–4 (8*)
Removable media	0–1 (2 with low profile DVD)	0–2 (4*)

*Including SEU-2

Racking

Both the HP 9000 rp7440 and rp8440 Servers provide industry-leading performance density and availability in a racked configuration. At 10 EIA units (44.45 cm [17.5 inches]), up to four HP 9000 rp7440 Servers can be mounted into a single HP 2-m cabinet. At 17 EIA units (75.57cm [29.75 inches]) each, two HP 9000 rp8440 Servers can be mounted into a single HP 2-m cabinet, with 7 EIA units of extra space for mounting external peripherals.

The industrial design and packaging of the HP 9000 rp7440 and rp8440 Servers allow easy and quick access to all of the system components. The most frequently handled removable media devices and disks are directly accessible at the front of the system. Removing the front bezel allows complete servicing of hot-swap fans, hot-swap BPSs, and redundant PCI-X power supplies. At the rear, core I/O and more hot-swap fans are directly accessible.

The rack-mount kit for the HP 9000 rp7440 and rp8440 Servers consists of the following:

- **Slide kit**—Slides that safely support a fully configured product that must be serviced from the top and sides, so the slides must extend away from the rack front columns
- **Anti-lock mechanism**—A method of preventing sliding of more than one server from the rack at a time to prevent tipping over
- **Ballast weight (only required for HP RBII rack, ordered separately using order number J1479D)**—A method of safely counterbalancing the HP Rosebowl II (RBII) rack enclosure when the product is deployed for servicing
- **Anti-tip foot (only required for HP 10000 G2 Series Rack, ordered separately using order number AF064A)**—A method of safely counterbalancing the HP 10000 G2 Series Rack when the product is deployed for servicing
- **Cable management arm**—A design to manage cable bundles at the rear of the product as the product slides

For access to all other components, the rack-mounted versions come with rack slides. These slides enable the servers to slide forward out of the cabinet for servicing of internal components such as fans, cell boards, and I/O cards—even while the system is still operating.

The slides also allow for servicing or replacement of any field replaceable unit (FRU) without removing the chassis from the cabinet. In fact, you can access and remove any FRU within 15 minutes or less. This design reduces the downtime associated with system upgrades in the rare event of a component failure.

The interlock is a safety feature that is used when more than one product is to be installed in a single rack. This feature works only when two products are mounted on slides adjacent to each other (above and below) in a rack. The function of the anti-lock mechanism is to prevent sliding of more than one server from the rack at any given time. In the absence of this mechanism, if two servers are pulled out at the same time, the rack can tip over.

For stability during servicing, ballast kits are used on HP cabinets in which the HP 9000 rp7440 or rp8440 Servers are installed. The ballast weight base mount is designed to counteract the movement of one product in an HP RBlI rack when extended out on its slides for servicing. The ballast weight also works in conjunction with the interlock mechanism to counteract the movement of one or two products in an HP RBlI rack being extended for servicing. Every system that HP ships, excluding pedestal models, includes a ballast kit. The ballast weight easily attaches to the rear anti-tip foot that comes standard with every HP Rack System cabinet. Use of the ballast kit is mandatory for safety and for warranty validation, and the kit should be installed immediately.

Also included with every HP 9000 rp7440 and rp8440 Server is a cable management arm (CMA). The cable management arm is a two-member trough system that resides at the back of the chassis and guides cables during extension and retraction of the product. The CMA neatly secures data cables and prevents them from becoming entangled while the system is being serviced.

Third-party racks

HP servers are designed to maximize performance density when installed into HP system cabinets. Moreover, HP system cabinets maintain the high level of safety and reliability that you have come to expect. Although HP strongly recommends racking in HP cabinets, some circumstances might prohibit this. Therefore, HP has developed guidelines that enable safe, reliable HP server installations in third-party cabinets. Because of the wide variety of cabinets in the marketplace, it is extremely important that the guidelines be followed explicitly. See Chapter 4 in the *HP Server Configuration Guide* for the racking guidelines.

Server virtualization

Virtualization means that the physical resources are separated from the logical view of the server infrastructure. Server virtualization helps administrators to improve the usage and simplify the management of single or multiple server environments by configuring them as reusable pools of resources. The HP Virtual Server Environment (VSE) for the HP 9000 rp7440 and rp8440 Servers does just that—sharing, pooling, and allocating of server resources to optimizing utilization, adapting to changing IT needs while driving down cost.

With the HP VSE, you can increase your utilization of the HP 9000 rp7440 and rp8440 Servers, maintain nearly continuous service levels, and pay for only what you use. The HP VSE consists of tools for intelligent control, features, and tools for partitioning the server and availability and provides the flexibility of utility pricing.

The HP 9000 rp7440 and rp8440 Servers and the HP VSE offers the broadest range of hard and virtual partitioning solutions in the industry to provide data center security and uptime, while simultaneously maintaining the highest degree of flexibility. Resource virtualization can be done at the server, hard partition, or soft partition level. The two strategies for partitioning available to you are hard partitioning (nPars) and virtual partitioning (vPars). Each partitioning strategy splits the resources in the server (processors, memory, and I/O) into instances that can each run an operating system instance.

Hard partitions

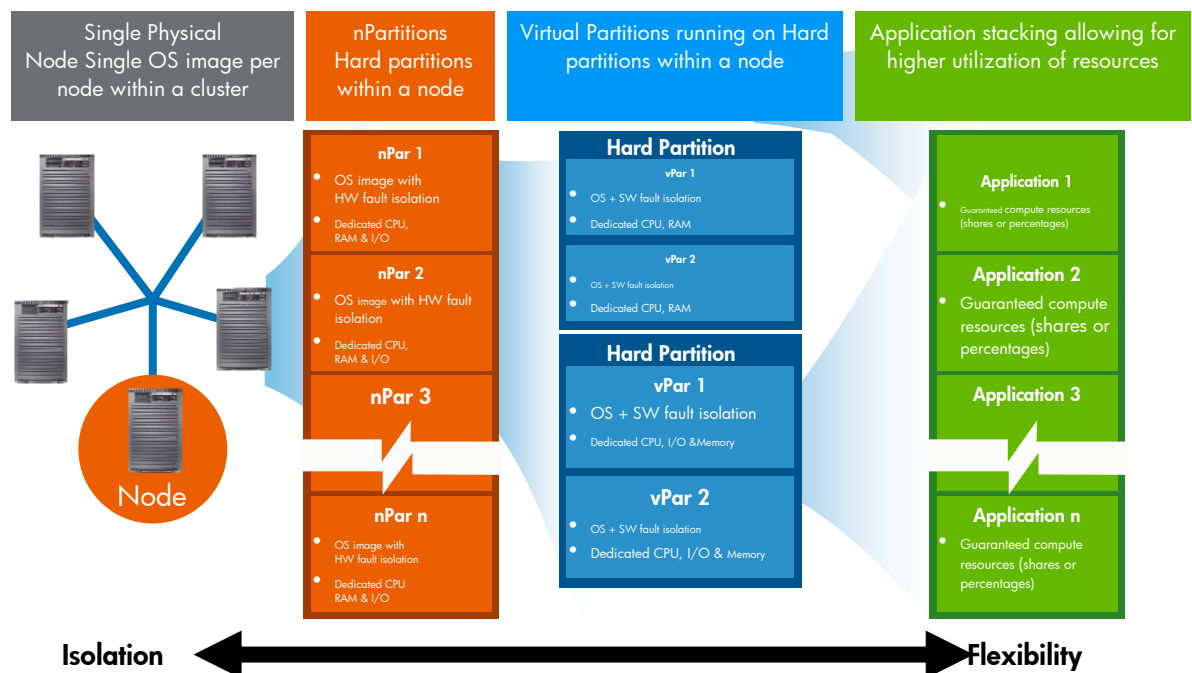
Hard partitions (nPars) are electrically isolated hard partitions with security provided in the hardware. Facilitated by the MP and secure firmware, you can configure the sx2000 fabric to isolate resources in an nPar from the rest of the system, which creates a hardware firewall to prevent other operating system instances from disrupting that partition. The firewall also reduces the chance that a single failure (in hardware or software) can take down multiple partitions. This feature is required to perform hardware maintenance on one partition while the other partitions continue to operate.

The size of nPar partitions can range from a single cell board to the entire system. nPars are available in every HP 9000 rp7440 and rp8440 Server with no additional purchase or licensing requirements.

vPars

The other partitioning strategy, vPars, runs within a hard partition as shown in Figure 19. Available on HP-UX 11i, vPars offer partitioning granularity down to the processor core level and the performance necessary for key applications because there is minimal overhead to coordinate among the guest operating environments. vPars also provide software fault isolation and security with the ability to dynamically move processor cores from one vPar to another within the same physical server or nPar, enabling you to dynamically allocate processing cores to and from the partition, scaling it with your usage.

Figure 19. The HP Partitioning Continuum for the HP 9000 rp7440 and rp8440 Servers



HP Essentials Global Workload Manager

HP Essentials Global Workload Manager (gWLM) is the intelligent policy engine for the multisystem HP VSE. HP gWLM improves the utilization of resources in a multiserver, heterogeneous rp7440, rp8440, and other HP Integrity and HP 9000 servers using HP-UX 11i, OpenVMS, and Linux platforms. HP gWLM flexes hard partitions by activating and deactivating temporary instant capacity

processors and the virtual server resources that can run within the server hard partitions (resource management groups, soft partitions) across an entire multitier application based on the demand generated at the front end. By ensuring that each service can access the resources it requires to meet its service levels, HP gWLM reduces the complexity and management challenges associated with multitier applications and web services.

For more information on virtualization and the HP VSE, see the white paper *HP Virtual Server Environment for HP Integrity and HP 9000 servers—Optimize server utilization in real time*.

HP Instant Capacity

With HP iCAP solutions running on HP-UX, the HP 9000 rp7440 and rp8440 Servers can be fully populated with high-performance Dual-Core PA-8900 processors at a significantly lower cost. It is no longer necessary to fully pay for inactive processors—with iCAP, you only pay when you start using the extra capacity. These additional processors can be activated with a simple command, providing immediate increases in processing power to accommodate application traffic demands.

iCAP is also an availability feature. In the unlikely event that a processor fails, the HP system automatically replaces the failed processor on the cell board at no additional charge—without rebooting. In online mode, the iCAP processor brings the system back to full performance and capacity levels, reducing downtime and ensuring no degradation in performance.

HP Temporary Instant Capacity (TiCAP) is the ability to turn iCAP processors that are already installed in the system on and off for short periods to provide added capacity. TiCAP gives you the ability to adjust to unplanned or planned spikes in computing.

Cell board iCAP extends the iCAP value proposition to include a complete standby cell board (processors and memory) in the system for a fraction of the cost. When processing capacity is needed, simply activate the cell board (memory and at least one processor) to immediately increase the compute power of the server.

HP iCAP tools use the following algorithm to activate new processors:

1. Verify that there is at least one active processor per cell board.
2. Activate processors round robin style across cell boards within a partition—the number of active processors per cell board differs by, at most, one across the partition.
3. Enable processors on a cell board in the order 0, 1, 2, 3 to spread the processors across the two internal cell controller buses and allocate processors in the best thermal fashion.
4. When a failed processor is replaced, choose one from the same cell board when possible; if that is not possible, choose the next available processor, following rules 2 and 3.

For increased performance, all cell boards in the same partition should contain the same number of active processors. For high availability reasons, each cell board should contain at least two active processors.

High availability

High availability (HA) continues to be the hallmark of HP computer systems. But HP knows that delivering solutions that fully enable the highly available 24 × 7 operations demanded of today's businesses requires more than just delivering laundry lists of unusable HA features—or HA features with limited utility. The high availability features of the HP 9000 rp7440 and rp8440 Servers address the real causes of downtime, as determined by actual field data from midrange computer users.

The HA features of the HP 9000 rp7440 and rp8440 Servers can be classified as those that address per partition reliability and those that address intra-partition reliability—that is, single points of failure between hard partitions.

Partition reliability

The HP 9000 rp7440 and rp8440 Servers have a design that is significantly “hardened” over other systems in their class. In fact, many of the features in these midrange systems can only be found in mainframes (or in HP Superdome). The reliability features within each HP 9000 rp7440 and rp8440 Server partition have been field proven to provide high system reliability. And many users who have used these features report significantly lower hardware failure rates than with competitive systems.

Processor protection

The processor is often a major cause of system downtime. For instance, processor cache errors are demonstrated to be a large contributor (in many cases, the greatest contributor) to unplanned system downtime. Furthermore, addition or modification of processor resources is among the highest ranking causes of planned hardware downtime. But in the HP 9000 rp7440 and rp8440 Servers, HP has designed specific features to combat processor caused downtime, including the following:

- Full error checking and correcting (ECC) on all caches
- Automatic deconfiguration of “faulty” processors (known as Dynamic Processor Resilience [DPR]) on servers running HP-UX
- A highly effective and reliable processor cooling scheme
- Processor hot-spares using HP iCAP on servers running HP-UX
- Redundant processor power converters

ECC on caches

The processor caches in the HP 9000 rp7440 and rp8440 Servers are fully protected from single-bit hard errors and random soft errors generated from cosmic rays or other intermittent error-generation sources. Some competitive systems in the same class are not similarly protected, resulting in errors that are hard to debug and that are, in many cases, blamed on the customer environment. Such cache errors in these unprotected systems can result in failures that bring down multiple partitions.

Another advantage of the HP 9000 rp7440 and rp8440 Server processor cache is its layout, which significantly reduces the chance of a multibit error due to a random cosmic ray strike. Such attention to detail is not found in many designs available from other vendors.

Automatic processor deconfiguration

DPR refers to the ability of the system to detect, deallocate, and swap in spare processors online for processors that are generating an excessive quantity of recoverable cache errors. This feature protects you against the extremely unlikely event of a double-bit cache error. This is one example of the self-healing features of the HP hardware. Implementation of this feature results in no downtime or performance loss. This feature is not currently supported with Windows.

Processor cooling

Heat is the big enemy of electronic components. The two-level cooling scheme of the HP 9000 rp7440 and rp8440 Servers offers outstanding cooling capacity at a nominal cost. The turbocooler fans of the servers draw air directly into the heatsinks of the processor and cell VLSI. At the extreme operating ranges of the HP 9000 rp7440 and rp8440 Servers, the turbocooler fans keep temperatures well below the maximum values allowed. Even though the turbocoolers might not be required under normal operating conditions, running them ensures that the silicon chips operate at the lowest temperature, helping to ensure maximum lifetime.

To further improve reliability of the HP 9000 rp7440 and rp8440 Servers, manageability software monitors the speeds of all fans, including turbocooler fans. The smart fan controller of the HP 9000 rp7440 and rp8440 Servers can detect the first hint of slowdown associated with bearing wear, ensuring you get plenty of warning before a fan fails.

HP Instant Capacity

HP iCAP is a means of adding and removing processors in a partition. With iCAP, you do not need to worry about:

- Interleaved memory
- Application locked memory
- Server switchovers due to false failures
- Physically handling processors or memory boards
- Rebooting

iCAP is the most reliable means of reducing planned downtime for hardware upgrades.

Memory protection

Main memory failures are the single largest cause of customer downtime. The HP 9000 rp7440 and rp8440 Servers have several features designed to reduce failures of memory:

- Double Chip Spare (DCS)
- Dynamic memory resiliency (DMR)
- Automatic deconfigure on reboot
- Hardware memory scrubbing
- Industry leadership address/control parity protection

Double Chip Spare

The HP 9000 rp7440 and rp8440 Servers support extensive state-of-the-art error detection and error correction features. This protection is used on paths within the VLSI components and between the chipset components and processors, memory, and I/O, including processor buses, memory buses, I/O and fabric links, and I/O slots.

An enhanced feature in the sx2000 chipset over the sx1000 chipset is the DCS. This capability of the memory error correcting logic reestablishes chip spare correction after another DRAM in the same ECC codeword has failed. With DCS, firmware recognizes when the first DRAM has failed and deletes its bits from the ECC calculations, which enables the ECC logic to correct for a second DRAM failure in the same ECC codeword. This erasure can be applied to a single DRAM, all DRAMs sharing a bit of a bus, or all buses of a memory subsystem. This maximizes the coverage of this unique protection mechanism. This enhanced feature is a result of the HP advance research in memory technology and does not require more DRAMs per MB than was required for the sx1000 single chip sparing support. This strategy is more cost-effective than memory mirroring methods for protecting memory. The primary benefit of this HA feature is that it reduces system downtime to replace failed DRAMs.

Dynamic memory resiliency

DMR is the ability of the system to de-allocate failed memory pages online. This feature is similar to DPR; if a location in memory proves to be questionable (that is, exhibits persistent errors), the memory is de-allocated online with no visible impact. Assuming the HP 9000 rp7440 and rp8440 Servers are equipped with adequate memory to begin with, it is unlikely that the failed memory might have to be replaced over the life of the product, resulting in a significant reduction in both planned and unplanned downtime. DMR is superior to industry available hardware-only techniques because hardware-only techniques can quickly run out of spares. The HP page deallocation technique solves this problem, resulting in more spares than can possibly be used over the life of the machine.

Hardware memory scrubbing

Software-based memory scrubbers are limited in function because many operating systems and applications “lock down” memory, resulting in no possible access. The HP hardware scrubber

“cleans” memory without operating system or application knowledge, resulting in much better coverage.

Protection for I/O

I/O errors are another significant cause of hardware errors and downtime because the number of I/O cards in a typical system is significant and the I/O cards themselves are a part of the system most exposed to frequent human interaction in the data center.

To prevent downtime resulting from I/O errors, HP has designed the following features into the HP 9000 rp7440 and rp8440 Servers:

- Online replacement of PCI-X cards
- Hardware firewall of I/O errors to cell
- High mean time between failures (MTBF) for I/O cards
- Separate PCI-X buses for each I/O card

Taken together, these features reduce hardware downtime by at least 20% over similar servers.

HP 9000 rp7440 and rp8440 Server crossbar and I/O backplane protection

The backplane of the HP 9000 8440 Server connects everything together. Because all partitions share the backplane, high reliability and true domain isolation are very important. The specific features that address these areas are as follows:

- **Highly reliable ASICs**—The backplane ASIC is manufactured and tested with a process that results in 10X demonstrated reliability over comparable chips. This reliability results in virtually zero backplane ASIC failures in the field.
- **Redundant DC-DC converters**—The DC-DC converters that power the system backplane chips are fully redundant, reducing downtime associated with power conversion. (Power conversion is normally a significant contributor to failure rate.) Redundant DC-DC converters have also been added for the I/O backplane extending the same concept to the I/O subsystem.
- **Full end-to-end error correction and independent partition design**—The HP 9000 rp8440 Server backplane is built from two crossbar ASICs with point-to-point connections. Traffic within a partition is contained in that partition, so there is no sharing of links in a properly configured system. Each port of the crossbar chip is fully independent, allowing cells of different partitions to coexist without affecting each other in any way. In other bus-based systems, all domains participate in the coherency scheme and share address buses. Therefore, in these systems all domains are linked in some fashion, resulting in shared failure modes that might crash multiple partitions.

Also, unlike other snoopy coherency systems that must accept and respond to all coherency requests from all domains, HP 9000 rp8440 Server partitions have hardware firewalls dedicated to guarding partitions from errant transactions generated on failing partitions. A failure in one HP 9000 rp8440 Server partition does not affect any other partitions.

Finally, all data paths in the fabric are resistant to both random single-bit errors and persistent single-wire “stuck at” faults. Therefore, the fabric is resilient to any single-bit failure, including pin, connector, or solder problems.

Reliability in the cabinet infrastructure

In keeping with its focus on maintaining high availability, the HP 9000 rp7440 and rp8440 Servers include protection against failure within the cabinet infrastructure. The HA features in this area include true dual AC line cord support and complete resilience to service processor failures.

Dual AC line cord support

As described earlier in this paper, the HP 9000 rp7440 and rp8440 Servers can run on one or two totally independent power sources. Moreover, these two power sources do not need to be in phase or the same voltage.

Resilience to service processor failures

The HP 9000 rp7440 and rp8440 Server hardware has been designed to enable service processor failover when redundant core I/O cards are in place. Future firmware and manageability code releases are expected to allow a secondary service processor to take over for a failed service processor and also enable a resilient console (on reboot). Future operating system releases may allow the console to fail over as well.

HP continues to make great strides in implementing features that reduce the time to upgrade components or diagnose and repair component failures. The HP 9000 rp7440 and rp8440 Servers were designed with the objective of coupling state-of-the-art diagnostic tools with hardware features to reduce unplanned downtime. Hot-swap and hot-plug technology is implemented throughout the server, allowing addition or replacement of components while the system continues to run.

For components that cannot be serviced while the server is running, both servers were designed to provide access and removal of any FRU within 15 minutes or less. In addition, the HP 9000 rp7440 and rp8440 Servers are loaded with design innovations that greatly simplify servicing.

Enhanced serviceability

The following is a list of enhanced serviceability features:

- Hot-plug functionality for internal disks and PCI-X cards
- Hot-swap functionality for bulk power supplies and cooling fans
- 67.9-cm (26.75-inch) product length from mounting column to the connector mating surface at rear (approximately 76.2 cm [30 inches] overall with the front bezel sitting forward of the rack column), leaving 10.2 cm (4 inches) for cable bending in third-party racks
- PCI-X card access from the top of the chassis so that ceiling light enhances visibility
- Access panels as large as possible to enhance the service access area
- Five-sided access to increase accessibility
- Independent access to major FRUs (Any FRU can be accessed and removed within 15 minutes or less.)
- Access to most commonly serviced components from the front or rear without moving the product in the rack

Investment protection

The HP midrange server family provides outstanding customer investment protection and lasting value, with a system infrastructure designed to accommodate several generations of processor upgrades. For the HP 9000 rp7440 and rp8440 Servers, this means supporting PA-8900 processors today, with the ability to perform in-the-box upgrades to multiple generations of future Intel Itanium processors. No other competitor in this arena can offer the investment protection provided by HP midrange servers.

This makes upgrading easy and economical: you simply remove all the cells and the memory contained within the cells, transfer the memory to the processor cell boards, and install the processor cell boards into the cabinet. In addition, HP is investing in the Intel Itanium processor, enabling you to move to the new architecture when you are ready, not when your vendor forces you to. The HP microprocessor roadmap helps make the HP 9000 rp7440 and rp8440 Servers the safest and fastest midrange servers in the market.

Upgrading the HP 9000 rp7420 and rp8420 Servers

The HP 9000 rp7420 and rp8420 Servers are the current generation of the HP midrange server family that share several different components with their equivalent HP Integrity rx7640 and rx8640 Servers. These PA-8900 RISC-based servers can be easily upgraded to an HP 9000 rp8440 Server containing PA-8900 processors. Upgrading the HP 9000 rp7420 and rp8420 Servers is easy:

1. Remove the cell boards.
2. Upgrade system backplane.
3. Plug the cell board into the cabinet.
4. Remove or replace existing core I/Os.
5. Remove or replace I/O backplane board.
6. Upgrade system firmware (as needed).
7. Install desired operating system.
8. Change system bezel to reflect the correct system name and color scheme.

Today's HP midrange servers are already prepared for the next generation of processors so that they can stay ahead of tomorrow's performance demands. HP servers deliver investment protection through multiple significant in-chassis upgrades.

Ease of management

As the number of servers grows and server farms proliferate, IT professionals have come to realize that the cost of managing these servers can add up to many times the actual cost of hardware. In the HP 9000 rp7440 and rp8440 Servers, HP has provided features to make management easier and less taxing. Add HP management software that interfaces seamlessly with the HP 9000 rp7440 and rp8440 Servers, and provides lower total cost of ownership (TCO) and higher overall efficiency.

Management processor

Both servers have a dedicated MP that simplifies and extends system management and enhances serviceability. The MP feature set was designed to reduce the need for the system administrator to be physically at the system to perform tasks such as diagnostics, system management, or even hard resets. The MP enables you to remote manage the server, regardless of the system state. It can be used to power on or off the server, set up the hardware partitioning, view system status and event logs. The MP also enables remote console and console redirection for the multiple operating systems running on the server. The MP is embedded into the HP 9000 rp7440 and rp8440 Server core I/O and does not take up a PCI-X slot.

HP System Insight Manager

HP Systems Insight Manager (SIM) is the central point of administration for management applications that address the HP 9000 rp7440 and rp8440 Server management requirements. HP SIM delivers powerful monitoring and control, notifying the administrator of potential hardware or software problems before they occur. It also provides inventory-reporting capabilities that dramatically reduce the time and effort required to track server assets. HP SIM provides secure communications as well as role-based security to ensure that its powerful capabilities are kept secure from unauthorized users.

HP-UX

HP Essentials for HP-UX 11i are advanced plug-ins to HP SIM that provides modular, integrated system management software for complete HP server management. It integrates with many other HP-UX-specific system management tools, including the following tools available on HP 9000 servers:

- **Ignite-UX** addresses the need for HP-UX system administrators to perform fast deployment for one or many servers. It provides the means for creating and reusing standard system configurations, enables replication of systems, permits post-installation customizations, and is capable of both interactive and unattended operating modes.
- **Software Distributor-UX (SD-UX)** is the HP-UX administration toolset used to deliver and maintain HP-UX operating systems and layered software applications. Delivered as part of HP-UX, SD-UX can help you manage your HP-UX operating system, patches, and application software on HP servers.
- **System Management Homepage (SMH)** is used to manage accounts for users and groups, perform auditing and security operations, and handle disk and file system management and peripheral device management. HP Systems Insight Manager allows these tasks to be distributed to multiple systems and delegated using role-based security.
- **HP-UX Kernel Configuration** is used for self-optimizing kernel changes. The new HP-UX Kernel Configuration tool enables users to tune both dynamic and static kernel parameters quickly and easily from a web-based GUI to optimize system performance. This tool also sets kernel parameter alarms that notify you when system usage levels exceed thresholds.
- **Partition Manager** creates and manages nPars for high-end servers. After the partitions are created, the systems running on those partitions can be managed consistently with all the other tools integrated into SIM.
- **HP-UX 11i Webmin-based Admin** is a web-based system management framework that allows a wide variety of open source Webmin system management modules to be plugged in. HP supports this tool for the configuration of the HP-UX 11i Apache-based Web Server and the HP-UX 11i Tomcat-based Servlet Engine.
- **HP-UX Bastille** is a security hardening/lockdown tool that enhances the security of an HP-UX 11i UNIX® host. It accommodates the various degrees of hardening required of servers used for webs, applications, and databases.
- **Security Patch Check** efficiently improves systems security by performing analysis of file sets and patches installed on an HP-UX 11i system and generating a report of recommended security patches.
- **System Inventory Manager** is for change and asset management. It enables you to easily collect, store, and manage inventory and configuration information for HP-UX-based servers. It provides an easy-to-use, web-based interface, superior performance, and comprehensive reporting capabilities.
- **Event Monitoring Service (EMS)** keeps the administrator of multiple systems aware of system operation throughout the cluster, and it notifies the administrator of potential hardware or software problems before they occur. HP Systems Insight Manager can launch the EMS interface and configure EMS monitors for any node or node group that belongs to the cluster, resulting in increased reliability and reduced downtime.
- **HP Process Resource Manager (PRM)** controls the resources that processes use during peak system load. PRM can manage the allocation of processor, memory resources, and disk bandwidth. It allows administrators to run multiple mission-critical applications on a single system, improve response time for critical users and applications, allocate resources on shared servers based on departmental budget contributions, provide applications with total resource isolation, and dynamically change configuration at any time—even under load.
- **HP-UX Workload Manager (WLM)** provides automatic processor resource allocation and application performance management based on prioritized service level objectives (SLOs). In addition, WLM allows administrators to set real memory and disk bandwidth entitlements

(guaranteed minimums) to fixed levels in the configuration. The use of workload groups and SLOs improves response time for critical users, allows system consolidation, and helps manage user expectations for performance.

- **HP OpenView Operations Agent** provides a fully integrated, single-pane-of-glass management solution for systems, networks, applications, and databases. A powerful ability to monitor, filter, correlate, and respond to events enables IT organizations to establish central management control over their managed environments and improve overall availability and reliability.
- **HP OpenView Performance Agent** monitors and analyzes the performance of systems and applications to compare SLOs with actual application performance, and it enables real-time performance monitoring as well as action on alarm.
- **HP OpenView Glanceplus** is a powerful system monitoring and diagnostic tool that provides online performance information, examination of system activities, identification and resolution of performance bottlenecks, and system fine-tuning.
- **HP OpenView Data Protector (Omniback II)** provides reliable, high-performance data protection for enterprise-wide heterogeneous environments without impacting system or application performance. It centralizes and automates backup and recovery operations and tracks file versions and media to enable swift recovery of information.
- **HP OpenView Network Node Manager (NNM)** management station runs on Itanium 2-based HP-UX servers. NNM provides a powerful network management solution that includes concise, in-depth views of network devices and their status in an intuitive graphical format. NNM helps network managers evaluate network performance, pinpoint problem sources, and proactively manage their networks and network availability.

All other HP OpenView management tools, such as HP OpenView Operations, Service Desk, and Service Reporter, can collect and process information from the agents running on HP 9000 servers with HP-UX.

HP Services for the HP 9000 rp7440 and rp8440 Servers

Services and support for each operating system are available at the time the specific operating system is available or supported by the server.

Evolve your infrastructure confidently with a partner that stands accountable

When you are ready to take advantage of the performance improvements Itanium-based computing offers, HP has a full range of multi-OS services to help make the transition as seamless and painless as possible. HP can help you quickly and confidently introduce HP 9000 systems into your existing IT environment and capitalize on their potential for your business. HP offers assessment services to precisely define porting requirements and chart a course to deployment, implementation services to install and configure equipment rapidly, and education services to provide your staff with the expertise required to achieve better system performance. Throughout the evolution process, HP accepts full accountability for delivering on the service commitments that HP and its partners have made. The HP commitment to your satisfaction does not stop with the transition process itself. The HP multi-OS support offerings—from simple reactive to comprehensive mission-critical—reduce the risks associated with downtime after your HP systems are installed. HP is looking ahead to help with your long-term success by working with leading independent software vendors (ISVs) in both the technical and commercial markets to tailor their applications to the Intel Itanium 2 architecture thereby exploiting the full potential of your HP servers.

HP Services delivers end-to-end solutions that offer consistent quality and service levels across multiple platforms such as UNIX, Windows, OpenVMS, Linux, and NonStop Kernel as well as systems from

other well known vendors. With the introduction of the midrange servers based on the Intel Itanium 2 micro-architecture, HP is the only vendor that offers the services to support the implementation of multiple operating systems (UNIX, Windows, OpenVMS, and Linux) on a single Itanium-based server. HP Services can utilize its wide range of offerings and its experienced services personnel to help companies fully exploit the Intel Itanium micro-architecture capabilities while protecting their existing infrastructures.

Full lifecycle services

HP Services offers a portfolio of services that meet your business requirements across your IT lifecycle. Whether it's a discrete short-term engagement or a full-scale project deployment, HP helps you fully exploit the Intel Itanium architecture capabilities while protecting your existing infrastructures and IT investments by positioning you to meet your evolving business needs.

- **Evaluation and planning**—HP Services experts help your company determine the best strategy for seamlessly integrating Itanium-based systems into your existing infrastructure to improve performance, reduce costs, and gain control of your IT environment. Working closely with your team, HP helps you develop an architecture that matches your IT environment to your business requirements and then creates a detailed migration plan that provides specific recommendations based upon your IT needs.
- **Porting and migration**—HP offers flexible porting and migration services that help you retain or enhance your application functionality, reduce disruptions during migration, and take full advantage of the distinctive capabilities of the Intel Itanium architecture. HP can work with you to determine your porting and migration needs, devise a strategy for moving applications to Itanium-based platforms, and create a detailed migration plan. And HP can manage all the details, including porting and migrating your applications, migrating your data, integrating your applications with existing ones, and performing application tuning, if that is what you need.
- **IT consolidation**—HP offers IT consolidation solutions that help you enhance the use of your IT resources, achieve new performance and productivity levels, and evolve your IT environment to meet changes in demand. HP Services personnel help you identify your company's business and IT objectives, create an investment justification and architectural blueprint, develop a detailed design plan that incorporates specifics on the configuration and technologies of your company's solution, and deliver a complete, tested infrastructure implementation.
- **Deployment**—HP Services personnel have the experience and expertise to deliver services that can help reduce the risks, time, and costs associated with deploying new technology. Acting as your single point of contact, HP develops and implements a deployment plan—including configuration, testing, and installation of all equipment—that helps provide the seamless deployment of Itanium-based solutions into full production.

- **Ongoing support**—HP offers a variety of support levels that cover your entire IT infrastructure and meet your specific needs. Companies can count on HP Services to help them acquire the assistance they need to maintain control of and deliver business value through their IT investments. You benefit from proactive onsite services, defined escalation processes, and rapid fixes. Corresponding HP services for your storage and network systems provide an integrated support solution for your environment.
 - **Hardware and software support:** HP has a full spectrum of proven preventive, diagnostic, remedial, and repair services that include high-quality remote and onsite support, upgraded hardware service response times and coverage periods, fast and reliable access to HP response centers for software phone-in assistance, and software updates for selected HP and third-party products.
 - **Integrated support:** Support Plus and Support Plus 24 are integrated hardware and software services that are available when you require assistance that complements your internal IT resources.
 - **Mission-critical support:** To reduce exposure to downtime, HP can deliver mission-critical support for businesses running critical applications. HP uses proven processes, best practices, and leading remote support technologies to help provide maximum IT availability and performance. HP Proactive 24 Service includes proactive advice and assistance that helps you improve the effectiveness of your IT environment. The Critical Service offering combines proactive and reactive services, including availability assessments and modeling, benchmarking, performance optimization, remote monitoring, security, capacity planning, configuration, availability, and performance management services. No other vendor matches the HP worldwide standard six-hour call-to-repair commitment (subject to specific terms and conditions). In addition, through the HP Mission Critical Partnership, you have the opportunity to create a custom agreement with HP to achieve your business objectives through customized business-level commitments that reduce exposure to abrupt negative acts.
- **Education**—HP offers a full curriculum of education courses that can help improve the productivity and performance of your workforce. Through these courses, programmers and IT administrators can quickly become in-house experts on the Intel Itanium architecture and the operation of Itanium-based solutions for HP-UX, Windows, OpenVMS, Linux, and NonStop Kernel. Courses are delivered using a variety of methods—from customized onsite classes to self-paced, web-based sessions—that meet your company's learning requirements.
- **Technical services**—Even the most technically proficient IT staff might need assistance when implementing and managing its Itanium-based platforms, which is why HP offers technical services—discrete, focused engagements that provide on-demand expertise to supplement your own IT resources. HP delivers proactive technical consulting services across the entire IT lifecycle, from assessment and planning to high availability and performance to security and system administration.
- **Business continuity services**—HP business continuity offerings—including consulting, disaster-tolerant, business recovery, and backup and recovery services—can protect your critical high-value business processes against potentially serious outages. HP uses a proven best practices-based methodology to design and implement a solution and continuity plan that fits your company's specific business needs.
- **Managed services**—HP offers comprehensive managed services that deliver innovative on-demand and traditional outsourcing services to simplify the management of your IT infrastructure and reduce costs while helping you quickly address changes in the marketplace. Our proven, flexible approach enables you to outsource your entire IT infrastructure—hardware, processes, and people—with the knowledge that you can receive predictable support levels based upon approved service level agreements.

The HP difference

HP Services provides a full range of services to help companies like yours quickly and confidently introduce Itanium-based systems into their IT infrastructures. Through our world-class methodologies, proven processes, IT expertise, advanced support technologies, and partnerships with industry leaders, HP Services can help you gain the full benefits from this technology—better resource utilization, reduced costs, and improved return on IT investment.

HP provides consistent delivery of its services through a global network of operations, education, and competency centers. With more than 69,000 services professionals operating in 170 countries, acknowledged technology leadership, and a heritage of innovation in services, HP Services can point to an extensive track record of helping customers improve their ability to support their changing business needs.

Proven experience and expertise

Our global network of services personnel have unmatched experience and expertise deploying go-to-market solutions using best-in-class processes across the lifecycle. And no matter what services you choose—from assessment or porting and migration to complete deployment and education offerings to ongoing support or full outsourcing solutions—HP can help you take advantage of this next-generation architecture quickly and cost-effectively.

To learn more about HP Services, see <http://www.hp.com/hps/support>.

For more information

For more information, see:

- The HP 9000 server family overview website at <http://www.hp.com/go/hp9000>
- The HP 9000 rp7440 Server website at <http://www.hp.com/go/rp7440>
- The HP 9000 rp8440 Server website at <http://www.hp.com/go/rp8440>

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